VOL. 28, No. 6 November, 1921

THE PSYCHOLOGICAL REVIEW

ASSOCIATION AS A FUNDAMENTAL PROCESS OF OBJECTIVE PSYCHOLOGY

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From the early dawn of psychological history when thinkers first began to reflect upon the mysteries of human behavior, they were attracted to the processes of association especially as they are manifest in memorial and kindred activities. Strikingly enough, too, from our present point of vantage, the early Greek thinkers, standing upon a common-sense basis of reflection, merely described in the manner of an unadorned narrative what appeared to happen when one stimulus-object called out a reaction to another stimulus,[1] or when they essayed an account of the incidents involved in the act of remembering or recollecting.[2]

But with the rise of the modern spiritualistic psychology the problem of association became extended and the associational process was no longer looked upon as merely a fact of memory, but became regarded as a property of psychic elements or was considered as an explanatory principle to account for the succession and cohesion between states of mind. Thus, in either case the associational process became a universal condition for all psychological phenomena, even to the existence of a stable mind, and was subject, of course, to all the criticisms of which a thoroughgoing mentalistic psychology becomes the target.

Associationism, however, suffered less from this criticism, as the records of psychological history show, than from a

[1] As the classic passage in Plato's Phaedo, 73–6, bears witness.

[2] For example, Aristotle, De Memoria, II., 6–11.

general tendency toward innocuousness and superfluity induced by the displacing activity of biological theories. When in the middle decades of the nineteenth century psychological phenomena became looked upon as the activities of biological organisms a basis was found for mental phenomena (which were themselves now considered as processes within the structures of the organism). This basis it is needless to say was the neural apparatus. Now while the data of psychology still remained mental for the biological psychologist, the machinery of association as a general principle of psychic unity he could dispense with, though he retained it to account for the orderly connections between the elements of what he called the purely mental reactions, namely, imagination and thought.[1]

Comes now a time when psychologists are modifying their conception of their science, a time in which psychological phenomena are more and more frequently considered as total unitary adjustments to stimuli, and not either exclusively mental or physiological facts or parallels of the two.[2] As a normal consequence of this new attitude association becomes again a general process involved in all psychological behavior. Increasingly accepted becomes the view that association constitutes the connections between responses and their stimuli.[3] We submit that no psychologist, whatever be his theoretical views, would deny that conditioned reflex phenomena are associational facts.[4] Moreover, the workers in comparative psychology find it most expedient to treat the animal's

[1] For a statement that undoubtedly will remain for a long time to come the classic exposition in English of the history of Association, *cf.* Warren, 'A History of the Association Psychology,' 1921.

[2] In this connection, we believe that, although Hunter ('A Reformulation of the Laws of Association,' PSYCHOL. REV., 24, 188) appears to be arguing for a reformulation of the law of mentalistic association, proposing that it be not confined to ideas but also be made to include sensations, he is really suggesting that we should make association cover response acts as well as merely mental states. It is interesting to note that Hunter's quotations suggest the fact that while psychologists have always observed the connections between reactions it still appears that their failure to exploit the fact is owing entirely to their mentalistic presupposition.

[3] Hunter (*loc. cit.*) makes this point when he subscribes to the view that the principle of association is the principle of habit formation.

[4] Cf. Warren, *loc. cit.*, p. 257.

organization of stimuli and responses as definite facts of association precisely as in the case of the human organism.[1] Psychological history repeats itself then in the matter of the pervasiveness and importance of associational processes, but with how striking a difference in the two periods. Instead of a mentalistic property or a statement of mental connections, associational processes are now looked upon as definite objective facts of psychological behavior. The purpose of the following paper is to attempt to bring together some of the conspicuous points involved in an objective investigation of psychological association.

I. *The Problem and Nature of Association.*—In its largest aspects the problem of association is the determination of the nature of the orientation of the psychological organism in its surroundings and the means whereby this orientation is achieved. In other words, the problem of association is the discovery of the conditions for the various interrelationships between the organism and its environmental complexities.

In detail, psychological association refers to the effects which specific objects and particular grouping of objects have upon persons in eliciting from them responses of various sorts, and furthermore, the association problem involves the discovery of the effects upon the organism of the various changes in the relationship between objects. Now consider what this means when we add that psychological association carries over to the interrelationships of persons in social situations. Here we must take account not only of the intricate orientation of persons in exceedingly complex surroundings, but moreover, we must observe that the various individuals are mutually influencing each other in the course of such adaptations; so that while changing behavior to adapt themselves to each other they at the same time provide new stimuli for the further modification of the other person's behavior, which in turn creates for the individual in question newer necessities for adaptation and orientation.

[1] *Cf.* the work of Carr, for example 'Length of Time Interval in Successive Association,' PSYCHOL. REV., 1919, **26**, 335.

Precisely how important a psychological phenomenon association really is may be readily gathered from the fact that if we include its elementary forms it is indubitably a *sine qua non* of psychological activity. For the essential point about psychological phenomena is the intimate association of a specific response with a particular stimulus. When the organism has acquired responses sufficient to connect him with a large number of surrounding objects then we consider it as oriented in those surroundings, since the organism will then be able to perform behavior serviceable to itself in the given situation. In more complex situations, that is to say, when responses must be prepared for before their actual operation, and when the response must be delayed and in consequence aroused by substitution stimuli,[1] then we must also have our surrounding objects and events themselves so related as to form interconnected stimuli.

We repeat, that only on the condition that the objects or events of the person's surroundings are orderly and systematically connected can he develop intelligent and rational behavior. For intelligent behavior implies a final directness, certainty, and efficiency of responses which are impossible without a definite interrelationship of the various stimuli with other stimuli and with the person.[2] Let us therefore at the outset observe that we mean to depart from the older tradition of modern psychology and look upon psychological association not as a condition of happenings entirely within the individual himself, as the historical term association of ideas implies, but rather as a series of phenomena involving always the reactions of the person in specific relationships to surrounding stimuli, both things and persons. Not in the slightest does this mean that we entertain the idea of excluding from associational phenomena the connections between the individual's reactions. To do this would mean to pass over an extremely important series of psychological happenings. How far we are from committing such an error may be

[1] As in meaning reactions.

[2] This emphasis of the stimuli factors, in view of the spreading prevalence of the behavioristic conception of association, is probably the main point of our discussion.

judged from the fact that we do not even exclude from the forms of psychological association the connections between stimuli-objects themselves. When we accept the hypothesis that association means the reactional orientation of the individual we thereby make room for all forms of associational connection.

But we hear the strident voice of objection saying, "All this you have written represents association almost entirely as a condition of psychological behavior, an essential condition perhaps, but still a condition merely, whereas by common consent psychological phenomena are constituted of responses to stimuli." Especially pointed appears this protest when directed toward our inclusion among associational data of the relationship between objects, for it practically amounts to a destructive criticism of our theory. And yet an examination of the facts in the case renders this objection innoxious. To this examination we shall now proceed.

And first, we propose to suggest that although psychological association must always involve a prominent element of purely physical relationship between objects, relationships which indeed greatly influence psychological behavior, still such physical conditions do not become psychological data except through the influence they have upon reacting organisms. It is only because an object and its connection with other objects are coördinated with the responses of the persons that they become of interest to the psychologist. This means to say that from a psychological standpoint it is because the proximity of and similarity between reactions are induced in the person by the proximity and similarity between objects, that the latter are admitted into the psychological domain. Now let us see what is the net result that we have reached.

Briefly, we have arrived at this conclusion, that although we cannot exclude physical connections between objects from the domain of psychological association it is to be observed that their inclusion among the data of psychology is only justified because such objects and their association are the stimuli for specific forms of reactions. It remains merely to

add that when we generalize the question whether a physical object is or is not a psychological datum we must declare that the question depends entirely upon the functional condition of such physical objects, or in plainer words, depends upon whether they are or are not operating to arouse an organism to action. When a physical object induces a reaction in the organism, that object obviously becomes a datum for psychology and we call that object a stimulus.[1]

Nor is the situation any different in the case of connections between reactions even when the reactions are ideas, in spite of the frequency with which they have historically been considered the sole elements of association. Let us be absolutely clear in our contention at this point. Since nothing other than a response to a stimulus may be considered as a psychological fact, we cannot admit the mere connections between reactions as psychological data any more than the mere connections between physical objects. No, reactional connections are not psychological facts unless they are responses to stimuli. Be it observed, however, that this does not mean that each unit of response or reaction system must necessarily be the response to a stimulus. On the contrary, the response member of a stimulus-response couple may consist of a group of reactions not one of which is a stimulus to another but all taken together constitute the response to whatever object or action of an object or person happens to be the stimulus.

We doubt much whether we need to protest, after our foregoing discussion, that our standpoint is whole-heartedly naturalistic, and that as scientific data we make no distinction between physical and psychological facts, tremendous as are, of course, the differences between the materials of the two domains of study. But it may not be superfluous to repeat that not because responses are organic activities are they data of psychology but rather because they are specific responses to particular stimuli. It is for this reason that we pointed out the similarity between responses and stimulating objects, a similarity which we may best state by observing

[1] A datum of psychology, we assume to include a stimulus as well as a response.

that each is a reciprocal phase of a single psychological fact. Furthermore, if we agree that no more special psychological quality inheres in the response than in the stimulus we cannot possibly make the mistake that the reaction in an associational situation is anything but an actual adjustment of the organism. Frankly, what we have especially to guard against is the idea that an associational member must be some kind of inner process, the traditional mental state for example.

Was it not the overemphasis of the person's responses in the associational process which was responsible for the traditional view that made association refer exclusively to ideas, whether considered as thought processes or as general terms for all psychological activities (awareness)? Very true it is that, at least in human behavior, exceedingly prominent associational activities will involve primarily the implicit forms of action that usually go by the names of ideational and memorial behavior. All of the delayed reactions which constitute the foundation for all complex intellectual operations are made possible through the connections established between the reacting person and things by means of similar and chains of dissimilar ideational reactions. We must not overlook the fact, however, that ideational connections consist of only one phase or form of association, a fact which we have already indicated by saying that association comprises a foundation both for the general orientation of the organism in its surroundings and for learning the most complex intelligent and rational responses.

One point more before concluding this section. We believe our discussion has shown that, while association may well be considered as involving conditions of behavior, association always turns out in the final analysis to be itself a definite form of behavior. This condition refers as we have seen both to connections between stimuli-objects and between reactions. Now we want to point out that psychological association may be considered as a reactional condition in another sense, namely, whenever we build up specific sorts of responses to particular stimuli, or in other words when we

form associations, we invariably create a condition for the later operation of those associations when appropriate occasions arise. Obviously this condition of association which we are now discussing is unlimited in its comprehensiveness, involving indeed practically every one of our psychological reactions. We can no better state our point here than by saying that the fact of having formed associational connections means that we have prepared a condition for behavior which is nothing less than a latent associational reaction and which under appropriate circumstances becomes active. Accordingly, we might add that associational processes involve three phases of connections. The first phase is active, namely, the formation of the connections, phase two is latent and may be most appropriately called an associational condition, while the third phase is again active consisting of the actual operation of the formed associational connections.

II. *The Basic Roots of Associational Processes.*—Complex psychological association may be considered as rooted in and developed from at least two of the elementary properties of all psychological phenomena, namely, integration and differentiation of responses.[1] By differentiation of responses we mean to refer to the organism's apparent discrimination of objects and their qualities and of the auspices under which the organism is in contact with its stimuli. How is this discrimination manifested? We answer, by the differential behavior which the organism performs when stimulated by different stimulating objects and situations. Now we assume that this elementary and universal behavior quality lies at the basis of the organism's development of its elaborate stimulus and response connections.

Likewise, we postulate a similar foundation for associational processes in the psychological property of integration, by which we understand the intrinsic morphological organization of the responses of the individual. Such integrations of reactions are well exemplified in the development of acts of skill, such as the organization of strokes in writing, of

[1] In addition to integration and differentiation of responses we may consider psychological phenomena to have these characteristics, variability, modifiability, delay, and inhibition of reaction.

movements in dancing, and manual operations in handling complex machinery. Excellently also are the integrative processes observed in the acquisition of speech behavior in infants. Beginning with words the infant integrates these into phrases and sentences. Language in infancy is all the better an illustration of the integrative processes because it shows the line at which integration develops into and merges with the larger and more complex process of association. For the infant (and for the adult also) language is only to a limited extent integrational, while for the most part it is definitely associational. The line of distinction between integration and association we place at the point where a series of reaction systems merge into a larger reaction system. When acts are integrated into larger acts they lose their identity as separate acts, as in the case of the separate t–h and e strokes when they become the "the" reaction system. Per contra the association of reactions in a pattern of response[1] does not involve at all any loss of identity on the part of the associated members.[2]

Upon these two functional foundations and possibly some others are built up all the multifarious combinations of associational connections. Needless it is to say again that it is hardly possible to place a limit upon the number and intricacy of associations which a complex organism develops in its multitudinous contacts with the surroundings; but always the character of the associations, which in all ultimate analysis must of course be brought down to concrete, memorial, manual, or other sort of actual behavior, is determined

[1] Note that the term reaction system and reaction pattern themselves indicate the differences between integration and association. For the former refers to a single unit of behavior of no matter what degree of complexity, while the latter refers to an organization of reaction systems. On the side of the stimulus be it noted also that the reaction system would most probably be stimulated by a single and simple stimulus, while the reaction pattern may be associated with a single complex or a group of stimuli.

[2] Is it necessary to point out that associational and integrational processes may be temporally relative? That is to say, while we have considered integration as prior and more simple than association, this really depends upon the particular stage of development, since the reactions now being integrated may have previously been associationally connected.

by stimulus and response situations. Now since it is a fact that associations are intimately involved in every type and level of our behavior, it follows that there must be an enormous variety of association forms. In the following section we plan, therefore, to enumerate some of the outstanding types of associational connection.

III. *What are Associated?*—If psychological association means the connection and operation of responses to stimuli, then we are in immediate possession of a serviceable method for isolating the association data, namely, to specify the connections between responses, stimuli, and the settings of the stimuli.

For convenience, we plan to adopt the plan of calling simple any association of two or more behavior factors of not more than two varieties, while a connection involving more than two varieties of factors we will call complex. To illustrate, the connection of a stimulus and response, two stimuli, or two responses are simple associations, but when a stimulus, a response of one type, say an implicit reaction, and another type of response are joined together we will call the association complex. While it is certain that most of our reactions include the complex forms of association, we shall still find it very useful to make a list of the simple associations, even if they are finally found to be for the most part abstracted from the complex associations.

Following our proposed plan we may arrange the simple associations into the following classes.

A. The Simple Associates.

1. Associations of stimuli and responses.
2. Associations of stimuli and stimuli.
3. Associations of settings and stimuli.
4. Associations of settings and reactions.
5. Associations of settings and settings.
6. Associations of reactions and reactions analyzable into the following forms:
   - *a.* Association of two or more overt responses.
   - *b.* Association of two or more implicit responses.
   - *c.* Association of two or more partially implicit responses.

d. Association of two or more partially overt responses.
e. Association of overt with implicit responses.
f. Association of implicit with partially overt responses.

Before arranging the complex responses we may first discuss the simpler associations.

1. *The Association of Stimuli and Responses.*—One of the primary forms of association is the connection between stimuli and responses, since without doubt the fundamental psychological fact is the operation of a specific reaction system through stimulation by a particular stimulus. Such a segment of behavior is the basic fact in all orientation and learning adjustments of the psychological individual. Now it is possible to distinguish at least two classes of such associations on the basis of whether the association is primary or secondary. By a primary association we do not necessarily mean an association not acquired in the life of the individual, but one which although acquired by the individual has its basis in the structural character of the person and in the adaptational history of the species of which the individual is a member. As examples of primary and secondary association we may take for the former the reflex behavior segments and for the latter conditioned reflexes and acquired reactions of all sorts. The association in the latter cases consists of the development of response systems for adaptation to specific objects and events.

Another distinction in the domain of stimulus-response association is that between (1) the connection of stimuli with overt responses; this is illustrated by the reflex act, (2) between stimuli and implicit reactions, such as between ideas and their arousing objects, and (3) between stimuli and partially overt and partially implicit reactions; this last situation is exemplified by the connection between a stimulus object and a perceptual response. Needless is it to add that the two kinds of distinction are not mutually exclusive, and moreover even in a single complex action may we find all of the kinds of associates mentioned.

2. *The Association of Stimuli.*—Here we have merely to point out the fact that through the connection of objects, events, and conditions, with other objects, the individual is forced to connect and correlate his reactions to the end of achieving a greater control over his surroundings and of becoming more efficient in his adaptations. The primary process of psychological orientation is the organization of particular behavior combinations because of the interrelationship between objects and events. The general integration of behavior we might say is due to the necessity to adapt to many related objects in a given time. As an illustration of this situation we may take the case of typewriting, in which the various strokes or movements must be integrated in a definite form because of the connections between the stimuli, namely, the combinations of words and letters.

In the association of stimuli we may again distinguish between *primary* and *secondary* connections. In the former case the association between objects may be original and merely discovered by the person in his first contact with the stimuli in question, while in the latter case the stimuli are rearranged and brought into some new relation, in each case of course modifying the behavior of the person. Another name for the primary form of association between stimuli is natural association, while the secondary connections may be called contrived association. Natural connections between stimuli may be illustrated by the relation of two or more houses, and let us observe that by natural we mean only that the connections between objects are formed without the knowledge, aid, and consent of the particular reacting individual. Contrived associations are (1) connection between a stream and a bridge, a person with another person (man and wife, parent and child) or a person and some object (occupational post or residence) and (2) all informational and physical objects connected by learning, creating or through acts of skill.

Most emphatically must we suggest again that while no connection between objects constitutes a fact for psychology

unless such a connection operates to effect some form of reaction in an organism, still that connection need not be known by the organism. Very frequently such associations of stimuli are so subtle that the reacting person or observer does not know how connected objects or persons stimulate an individual to respond, nor why the stimulating objects or persons come to assume that office. In many cases, however, the basis of the substitution function is clear; it is found in the similarity or other resemblance between two persons or objects, in the frequency of their relation, and in other cases, merely by virtue of the recent connections between two persons, objects, or events.

To the writer's mind it appears possible that the experimental problem of mediate association finds its solution in the fact that we have just discussed, namely, that we can be stimulated to action by objects or persons whose connections with other things we react to are unknown to us. Another form of stimuli association is the connection between objects serving as signs to call out responses to other things or persons which they signify. This type of association finds a large place in complex action of all sorts and especially in reasoning activities. As compared with the association of substituting stimuli the person reacting to a sign which signifies something else is always fully aware of the relationship between objects. The entire work of scientific and other forms of inferential behavior consists in great part in the development of an efficient capacity to respond to things and conditions when their representing signs appear. To illustrate this form of association let us assume that the high temperature of a patient may stimulate us to seek the means of discovering and controlling a toxic condition or an increased rate of a chemical reaction makes us think of the relative capacities of given catalyzers.

3. *The Association of Stimuli with their Settings.*—Very frequently specific forms of our actions become what they are because of an association existing between stimuli, whether objects, places or events, and objects, places or events serving as the backgrounds or settings of those stimuli. Let us

observe that the specificity of psychological reactions is due not only to the stimulus-object but also to that object in its setting or background, and observe further that it is because these factors are separated that the person is liable to perform an erroneous reaction to the misplaced stimulus. The dependence of a stimulus-object upon its setting is especially familiar in the case of contrasting colors or objects. Through the changes which are introduced in the medium of stimulation by colors placed in close proximity we are made to react to colors differently than when they have other backgrounds. Similarly we are prone to call a man tall or otherwise, because we respond differently to him when he is compared with a shorter person, than when he is likened to an individual taller than himself. Again, objects and events affect us differently when they have certain backgrounds than when they have others. How markedly divergent are our reactions to the same music when played by acknowledged musicians than when executed by unknown persons; again novels or other books of the greatest merit when written by women are by that very fact unreadable for some people.

As to the classification of the associations between stimulating objects and their settings we may, because of the similarity of these associations with the connections between stimuli-objects, call them by the same name. Thus we may speak of natural, original, conventional, or contrived connections between objects and their settings. Among such settings we may include the hygienic and other conditions of the person, as well as the person's relative size and weight as compared with stimuli objects.

4. *The Associations between Reactions and Settings.*—Not only are reactions connected with stimuli-objects, but they may be conjoined with the settings of such objects; so that the setting will serve as a secondary stimulus to elicit the response. We believe that the ordinary case of hallucination is a type of reaction induced in the person by the setting or a stimulus which in the normal course of events would have produced that response. We may readily grant that whenever the setting alone arouses a reaction we must look upon

the setting as the stimulus in that situation, but we must in that case call the setting an auxiliary and not the adjustment stimulus. This is true even when no actual object can be the adjustment stimulus, as is the case in "seeing a ghost."

5. *The Association of Settings and Settings.*—At least from a logical standpoint we ought to include here the connections between settings and settings as a form of association. For if we agree that a stimulus-object may be misplaced then of course the stimulus-object would be connected with two settings. As a consequence we must agree that the connection between the two settings has some influence in conditioning the behavior of the person. That different settings may be related, follows further from the consideration that our reaction to a particular stimulus may be similar to our response to a different object merely because of the influence of a related setting; a government official may respond just as politely to an agent of an unfriendly power as to the representative of a friendly one, provided that in both cases there are present similar conditions which may merely be the diplomatic background. For our purposes here it is well to note that the same physical, social, or political conditions may constitute different settings for stimuli.

6. *The Association of Responses.* (*a*) *Overt Responses.*—In many manual and skill acts we can determine the acquisition of them to consist primarily in the organization of interrelated overt reaction systems to form a definite pattern of response to some stimulating object or situation. Typewriting or swimming illustrate the connection between such overt reactions.

(*b*) *Association of Two or More Implicit Reactions.*—Likewise series of implicit responses may be related to form a pattern response to stimuli, precisely as is the case with overt reactions. Indeed the association of implicit reactions was the first type of association noticed and studied, under the heading, of course, of ideas. In this as in the last paragraph it is necessary to observe that we intend to refer here only to the conjoining of responses and not the connection of

responses with stimuli, for in many cases when we have series of responses operating the preceding reactions serve as stimuli to the following.

(*c*) *The Association of Two or More Partially Implicit Reactions.*—The best example of such an association is the conjoining of verbal responses. Verbal articulations are morphologically overt activities but in their operation they may be as elements in thought activities, implicit meaning reactions.

Possibly it is truer to say that they are both overt and implicit, but because their morphological and functional aspects can be distinguished we prefer to speak of them as partially overt and partially implicit. Articulate speech involves large series of conjoined, partially implicit reactions, forming in their various patterns effective specific adaptations to surrounding stimuli.

(*d*) *The Association of Overt with Partially Overt Reactions.*—Any perceptual behavior segment in which the specific perceptual reaction system is connected with some particular overt response following it, is an example of this type of association. Inseparable is this connection arising from the fact that the partially implicit reaction system is a vestige of some actual overt response which is in a sense replaced by the overt action which follows it in the behavior segment.

(*e*) *The Association of Overt and Implicit Action.*—Thought and memory activities exemplify the connections between overt and implicit acts whenever the segment of behavior involves a definite change in some stimulating object, and this, we might add, occurs more frequently than not. In thought processes the implicit behavior may be so intimately related with overt byplay responses that we may truthfully say that pacing the floor, scratching the head and other overt byplay responses are intrinsic factors in the thinking. Better illustrated is this type of association by the facts of planning as anticipatory responses for overt acts as bridge constructing, military campaigning or other types of overt responses.

(*f*) *The Association of Implicit and Partially Overt Reactions.*—In every act of thought the implicit reactions involved are put into operation immediately or mediately by some substitution or associated object. Now the contact with such an object constituting the immediately preliminary reaction to the thinking processes is very frequently a perceptual or partially overt action. Our implicit responses are in great measure conditioned and modified by such connection with perceptual responses. In fact, it is the closer association of implicit responses with perceptual reactions which makes our diurnal thoughts and problem solving different from day or night dreams.

B. The Complex Associations.—As we have previously indicated, possibly the most satisfactory description we can give of complex associations is to say that they constitute various organizations of the connections which we have already attempted to isolate. Thus every complex reaction consists of many interrelationships of stimuli, their settings, and all of the varieties of responses. The primary point here is that the particular modes of orientation and adaptation of the person to his surroundings are functions of numerous specific connections which the person makes during his development and growth, within the range of his surrounding stimuli. Thus for example, in every perceptual behavior segment the specific occurrence involves a connection between the partially implicit and overt responses, with the additional connection of all of these factors with implicit responses. In more complex acts such as planning, the situation is even more elaborate and complicated, and while these acts may involve many overt responses they are so named as to suggest primarily implicit activity because such responses play an unusually important part in the total behavior.

IV. *How Associations are Organized.*—Having enumerated various kinds of association, the problem arises as to what are the attendant circumstances under which these various connections are made. Not only is it clear that different conditions may be responsible for the formation of different

associations, but it seems evident that any individual connection may involve a number of specifically different kinds of conditions.

Concerning all of the associations involved in our behavior taken *en masse* we may assert that two general methods of bringing the associated terms together may be isolated, (1) the casual connection of stimuli and responses, and (2) the deliberate connection of the associated terms. By casual association we mean any connection between stimuli and responses or other terms which are not planned or brought about in any purposive manner.[1] The various language responses illustrate both forms of association. We strive to make the child in its early infancy adopt definite, prescribed word responses as the names for objects and thus learn to communicate with others. For the most part, however, the child acquires specific language responses through the sheer casual stimulation by the sounds of other people.

Cutting across both of these modes of forming associations are the more specific conditions observed in the formation of connections. Thus a response may get connected with its stimulus because of frequently having been associated, or because of the great vividness of the conditions under which the associations are made. The conditions are operative whether it is a mannerism which is unwittingly acquired or whether the situation is the training of a child in school. Probably the different conditions can best be isolated by considering separately the six general kinds of association.

1. *Stimuli and Responses.*—To consider first the connections between responses and stimuli we find that such connections are due in some form or other to some or all of the following conditions. (*a*) The necessity of the situation may force us to make particular movements in order to prevent injury or to make any or an adequate adaptation to certain stimulating conditions. Older boys assume this principle when they throw the uninitiated youngster into deep water as a method of forcing him to learn how to swim. Such

[1] It is immaterial, of course, whether the deliberation is that of the acting person or someone else.

needs as we have suggested extend of course to social requirements and prohibitions as well as to physical necessities. (*b*) The frequency with which we perform a given response to a stimulus conditions the formation of a connection at all or the rapidity with which such an association is made. This condition applies more to routine and mechanical forms of responses. (*c*) In many cases an association is formed because of a recent contact with a stimulating object. This condition operates only in what we will later designate as the temporary associations. At this point it is well to suggest that in many cases the sole warrant for asserting the presence or existence of certain associations lies in the fact that we can observe them to operate. The application of this fact receives its importance here in the consideration that an association may be formed and operate once only and never again. In such a case the condition of recency has its most plausible application.

(*d*) Another very strikingly contributory condition for the formation of associations is the vividness of the circumstances under which the reaction is made to the stimulus. Illustrative of this condition are the first acquisitions in school, the facts occurring in the presence of persons loved, feared, or respected, and associations made in the presence of danger or distress or under conditions of great happiness or importance to the person. (*e*) Associations involving rewards and punishments of various sorts are facilitated or hindered by these conditions in whatever form they occur. (*f*) And in many cases associations are developed as definite or indefinite means to ends. A prospective engineer acquires mathematical training as a basis for future use in his profession. Clear it is that the conditions here overlap in many cases the motive for the formation of associations, but we allow in this separate division for many conditioning motives, as in the illustration of the engineering student. (*g*) Whether an act is pleasant or the opposite, determines in great measure whether and how soon given associations will be made. (*h*) And as a last condition in influencing the connection of

responses and stimuli we may name the motive of self-aggrandizement and self-satisfaction through the influence of which many associations are made and the acquisition of reactions facilitated.

2. *Stimuli and Stimuli.*—(*a*) Exceedingly prominent as a condition for the association of stimuli is the similarity or other resemblance between things or persons. The resemblance then, is a basis for the substitution of one object or person for another in a memory, thought, or imagination action. Possibly the resemblance may be owing to a partial identity of the stimuli such as the possession by each of a particular color or some similarly shaped common element. Illustrative of this type of connection is the case in which upon observing an unknown person on the street we call out the name of a friend only to find that a single more or less pronounced resemblance was responsible for arousing in us what we may call a misplaced reaction. This elementary fact of association we may consider to lie at the basis of all highly developed forms of classification such as we find in the earlier stages of all science. To be more succinct, the complex classificatory behavior of science and its development into the activities of organizing phenomena has its roots in the concrete fact that we make the same or similar reactions to similar stimuli.

(*b*) Another very important condition for the association of stimuli is the existence between them of some definite form of relationship. Objects may be related in series of various description so that the appearance of one may serve to arouse responses associated with all or some of the other members of the series. Besides membership in series, objects and events may be related as causes and effects, antecedents and consequences. Personal relationships as father and son, husband and wife, brother and sister, etc., may be the condition for the reaction of the person to an absent stimulus when the associated stimulus is present. What we mean by insight into and knowledge of things and processes is the development of expectancies and predictional capacities for events when their related phenomena are present.

(*c*) Meriting separate discussion is the connection of things or events because of the fact that stimuli-objects impress themselves upon us as signs for a thing or event signified. Through the connection of objects as possible symbolic representations of one by another we acquire our capacities to use objects needed as instruments of adaptation to conditions, but which are not now within actual reach. Here we find one of the prominent bases for all the higher forms of intelligent behavior, for in the symbolic relations of things we already have an elaborate interconnection of actions with combinations of stimuli-objects.

(*d*) Just as in the case of the association of stimuli and responses so here we find also that the frequency of connection between two objects or persons is conducive to the operation of one as a substitution stimulus for the other, and in consequence enlarges the scope and increases the effectiveness of our action.

(*e*) Recency serves likewise in this situation to connect objects and events, although the condition is limited in its potency to bring about serviceable connection.

(*f*) And finally as a contributing condition to the organization of connections of stimuli we might add contiguity or the sheer and accidental connection between objects, events or persons.

3. *Responses and Responses.*—(*a*) In the association of responses the frequency of connection is a very effective condition for the establishment of a relationship. This fact is illustrated by the rule of much practice for the acquisition of informational and skill responses. (*b*) Similarly recency operates as a condition for bringing together in more or less permanent form the members of a series of responses. When manual or verbal responses are in question then (*c*) rhythm is a patent factor in the formation of connections. (*d*) In the connection of verbal responses sound similarity is very important in many cases for the establishment of a connection which may resolve itself into actual rhythm. When we consider such associations as language responses we cannot over-

look the great importance of (*e*) custom and usage in the formation of response connections as well as in their dissociation.

4. *Stimuli and Settings.*—Significant as conditions for the establishment and continuation of these associations are (*a*) the sheer location of a stimulus object in its particular surroundings, and (*b*) the constancy of the location and connections between the stimulating factors.

5. *Responses and Settings.*—This type of association would clearly be conditioned by the same factors as (1).

6. *Settings and Settings.*—Whatever seems effective for (2) would appear to operate in this case also, although the connections here are not ever so clear cut or so permanent as in the case of the connections between stimuli and stimuli.

As a summary of this section we might suggest that our extensive, though certainly not exhaustive enumeration of the conditions surrounding the establishment of the various forms of association connections serves energetically to emphasize the individual direction of such connections. We mean to stress the fact that each associative connection, whether fortuitous or designed, casual or deliberate, is a unique fact and in consequence is a member among innumerable classes of events. Definitely, we mean to deny that there is a law or series of laws which can be considered either as a general statement of what brings about association or as a limited series of particular conditions exclusively contributing to the formation of associational connections. As we view the matter there are as many laws of association, if we insist upon the use of the phrase, as there are actual connections of psychological facts. This way of looking at the data of association constitutes merely a suggestion of the original character of all psychological phenomena and especially of human reactions.

V. *The Operation of Association Processes.*—Strictly speaking, the mechanism of association includes both (1) the processes of organizing connections between stimuli and acts, and (2) the operation of those reactions when formed. In

fact, these two processes are simply reciprocal phases of a single mode of behavior, although for practical purposes they may be treated apart. In many cases, however, as we have already seen, the two processes are not readily observable, since the fact of having formed certain connections is evidenced only by the fact of using them as in recalling a name or in the performance of skilled acts as repairing a piece of apparatus.

While the simplest associational operations consist merely of the functioning of a reaction system or a pattern of such reaction systems when the connected stimulus appears, the most striking and effective are those mechanisms in which the reactions of the person are brought into play by indirect stimulation, that is to say, through the mediation of a substitution stimulus. The importance of the substitution of one stimulus for another may readily be inferred from the fact that all complex delayed reaction consists of the operation of some response to an object or person other than the object or person which stimulated the individual to act. By the term complex delayed behavior we mean to distinguish the so-called ideational and memorial reactions from the simpler reactions which for only very brief periods are delayed from operating through their temporary replacement by orientation postures and attitudes, such as the crouching movements of the cat in anticipation of the appearance of its prey, or other similar forms of behavior. As compared with these simpler reactions the complex delayed reactions may in general be considered as the basis for all higher forms of intelligent conduct.

Typical functioning of the complex associational processes may be observed in memorial behavior, since our memory activities consist practically in the operation of reaction systems excited to action by means of substitution stimuli originally connected in some way with the object substituted for. Possibly this associational reaction may be even better observed in the study of language and reading reactions. In these forms of behavior sounds or printed symbols serve as substitution stimuli to arouse overt or implicit reactions

to whatever objects or persons are symbolized. Essentially, we repeat, the machinery of complex behavior is the interconnection between a given reaction of the person and two stimuli, one the original object to which the reaction is developed, called the adjustment stimulus, the other, any related object which can call out the reaction in question.

But here we may well pause and ask whether we are not unintentionally overdoing our argument concerning the prevalence and importance of association. Specifically, we may ask whether, in fact, an implicit action or idea can be associated either with an adjustment or a substitution stimulus. Our answer to the question is unequivocally affirmative and this answer we give because we believe ideational association is in essence a process of living over some past situation.[1] It is a process of repeating in an implicit manner some previous action. Possibly this point is most effectively illustrated in the observation that the process of recall which may be either an overt or an implicit act is merely the operation of a postponed reaction. My recalling an engagement may involve the overt act of immediately walking toward a certain point stimulated by the visual perception of my memorandum book, or it may be merely an act of determining and planning to go there induced by the same stimulus. Possibly it is not inadvisable to interpret the postponed act at the time of its actual operation as a substituted act, especially if we keep in mind the difference between it and the replacement acts mentioned above. Whether the postponed act is overt or implicit the event consists of a delayed response made possible by the connection of reactions with stimuli.

No better can we observe the operation of association than in the study of learning, for as a psychological process learning consists of the active connection of responses both overt and implicit, with specific stimuli. The overt responses may be manual or verbal, while the implicit reactions may involve any kind of indirect response to stimuli. When the responses are entirely indirect some actual contact between

[1] *Cf.* Kantor, 'An Objective Interpretation of Meanings,' *Amer. J. of Psychol.*, 1921, 32, 231–248.

the person and his surroundings is maintained, of course, through perceptual activities. We assume the learning to be accomplished when the associations are so firmly established that whatever reaction systems are acquired will operate whenever their appropriate stimuli are presented. Now when a person in his various contacts with his surroundings has made many associations between his responses and stimuli we may truthfully speak of his capacities to do various things, for not only is he equipped to respond definitely and directly to particular stimuli, but also by virtue of having made a large number of associations, he is equipped to meet new situations, situations exactly like which he has never faced before, provided always, however, that conditions common to older circumstances are present. Learning and the capacities to which the process gives rise consist of the postponed operation of a reaction to a stimulus with which it has previously been connected.

For the most part it holds true that our intellectual and manual capacities depend directly upon the development of associations through actual contact with particular objects and conditions. Inventive skill, the ability to discern relationships in things, as well as expertness of judgment in given situations can all be readily traced back to frequent and constant association with the objects and events in which the person excels. In many cases what appears as a mysterious intuitive faculty can be shown to have its direct origin in such preoccupation with particular facts. Was not the discovery of the table of periodic relationships between chemical elements based upon such associational facts and are not mathematical discoveries and the capacity to classify animals rooted in the same associational soil?

Digressing a moment we might point out that the study of association as a basic and universal form of behavior throws light upon the extremely important problem of psychological capacity. Note that by capacity we always refer to an action, although it may be a potential or possible action. Now a potential action in psychology is merely a postponed or delayed response, postponed we say because the action

was really started when the original association between stimulus and response was formed. My capacity to multiply, to play the piano and to draw, affirms the fact that I have acquired such associational connections between responses and stimuli; so that now the presentation of stimuli elicits their characteristic responses. By the same token the acquisition of many definite responses to particular stimuli leads also to the formation of more general and formal phases of action, and so we acquire general drawing, multiplying, and other capacities as well as the specific capacities to draw particular pictures or to multiply particular integers.

Observe then, that the general capacities refer to such phases of actual behavior as are common to all particular acts of a certain type. When we have multiplied enough pairs of integers and composed enough particular musical forms, we can thereafter multiply new combinations of integers and compose other pieces, but neither of these new activities will involve absolutely new factors; rather they will comprise individual and common behavior elements which have previously been associated. The less specific aspects of behavior give us then only relatively general capacities. That our so-called capacities are significantly rooted in previously acquired associations we note from the fact that it is extremely difficult to modify the capacities we already possess, such as dispensing with or changing our "styles" in handwriting, literary and musical composition and other ways of responding to stimuli. That all our capacities consist of associational connections is further indicated by the fact that we can change our styles only by training and in general finding new stimuli. Because the psychological data, at least of the human domain, involve so many and so wide a range of capacities and tendencies, we may consider our present discussion as offering additional evidence for the universality and foundational character of the association processes.

The associational processes, however, do not only constitute the main operational machinery for intelligent behavior, but the number and variety of associational reactions

acquired determine also the differing qualities of high grade acts. Thus, the difference between merely knowing and originating within the domain of intelligent behavior is determined by the different associational mechanisms involved. In informational and other knowing reactions the substituted stimuli are very similar to the original ones, while in originating acts the effectiveness of the behavior depends upon the quantity and differences of stimuli that make behavior substitutions possible.

Possibly not too redundant is it to repeat again that the operation of previously acquired associations not only constitutes the higher intelligent reactions but also the simpler intelligence acts and capacities as well as behavior not specifically designated as intelligent. Especially must we observe that our passions, diffuse feelings and other types of affective behavior operate as they do in specific instances and bring about conditions in the relations between persons and their surroundings precisely through the same sort of associational machinery as we find operating in the so-called motor and ideational reactions. Now since the operation of associations always involves some specific type of adjustmental response we propose to discuss the associational mechanisms in a few typical situations.

1. *The Mechanism of Association in Manual Skill.*—How well the expert designer can plan a bridge depends entirely upon the suggestions his original data offer for the specific development of suitable structures and the harmonization of cost, appearance, solidity, and usefulness in the total construction. The specific workings of these suggestions consist of the substitution of the present data such as kind and location of site, and the needs of the situation for types of structures already built, studied, or projected. At each point in the work stimuli in the form of unwritten or spoken instructions, drawings, maps, plans, and instruments serve as substitution stimuli for reactions to detailed features of the whole situation. To take a simpler case of skilled behavior, the particular difficulties in the mechanism of an automobile, for instance, suggest other difficulties in other situations, or

ways in which the difficulties were overcome. In both cases of suggestion the substitution stimuli operate by calling out in the person implicit responses. Indeed, unless the present difficulties call out such reactions in the person no act of skill is possible, and the amount of skill possessed, that is, the number of successful operations, is an index to the number of associations previously made, excluding of course the associations being made at the time.

A similar operation of interconnected stimuli and responses providing the organism with orienting behavior is illustrated by animal reactions. A young pigeon making its first flight from the cote can be easily caught because it has not associated its reactions with specific surrounding objects and places of possible safety.[1]

2. *The Mechanism of Association in Memory.*—In memorial behavior the associations operate in two main ways. (*a*) Through them projected reactions are possible in the sense that substitution stimuli are intentionally attached to acts for the purpose of postponing some work or other action. The substituted stimuli may be time, as when we agree to do something at a given point in the future. In this case we would mark our calendar as the effective means of stimulation, or we may promise to speak to someone when we meet him. In this case we project an action into the future by means of words. Probably it is well to point out that here we have an action in which an indirect or implicit response occurs before the direct one, although in every case, of course, the direct association must have been previously made.

(*b*) The recalling of forgotten events or the performance of forgotten actions is brought about by almost any kind of object or situation, provided it has previously been connected with the forgotten event or act. The appearance of a certain person may be the stimulus for the act of paying the arrears in dues to the club to which the person had introduced us. In this case the specific mechanism is not controlled by the person and the act is unintentionally delayed, perhaps to the chagrin of the reacting person.

[1] See Whitman, 'Orthogenetic Evolution in Pigeons,' 3; 'The Behavior of Pigeons,' 1919, 157, edited by Carr.

3. *The Mechanism of Association in Imagination.*—In imagination reactions the associations between things serve as stimuli to suggest to the person associations between other things; so that the latter can be recombined and rearranged in various ways besides dissociated and reconnected with other things, persons, or events. In this type of reaction the fact of association or other relation between things serves as the effective stimulus to new forms of implicit behavior. Here as in other cases the efficiency of the person depends upon the number of previous associations actually formed; in other words the imaginal capacity depends upon the amount and degree of practice.

4. *The Mechanism of Association in Thinking.*—Thinking acts, involving as they do intimate responses to problematic situations, exhibit a multiplicity of forms of associational operation. In the first place, the capacity of the thinker depends upon the number of solutional ideas suggested to him by any problematic situation. As in all the other cases this suggestion is a function of the number of previous associations the person has already made with similar objects and conditions. How many associations are necessary may be readily estimated when we consider that each thought activity constitutes a unique behavior situation.

Throughout the entire series of complex association mechanisms there runs a common principle, namely, that such mechanisms enable the individual to perform a multiplicity of responses or at least suggest the possibility of multiple responses to a few or all of the immediately present objects or situations. This result is made possible as we have seen by the organization and reorganization of stimuli and responses.

VI. *The Modes of Psychological Association.*—Almost obvious it appears that such a constant and pervasive phenomenon as association is, will exhibit a variety of forms in the various behavior circumstances of individuals. We have already met with some of these varying modes in our discussion so far, but for purposes of further explication and in spite of repetition we may enumerate the following modes of association.

1. *Primary and Secondary Association.*—In the stimulus-response connections we find reactions which are originally connected with certain stimuli as in the case of a bit of meat serving as the stimulus for the salivary reflex action. Now when this reflex is conditioned we assume that the responses are attached to some other form of stimulus as the sound of a bell or an odor. The first connection accordingly we will call primary, and any succeeding connection may be called secondary, tertiary, etc., to the limit of associational capacity. Naturally, this classification will have to be mainly confined to simple forms of response, for only in the simple forms of behavior can we definitely determine what are original stimuli and only in such cases can we observe the appropriation by another or an additional object of the rôle of an inciter to action. No doubt, exists, however, that this process of transconnection between stimuli and responses is a common occurrence in our most complex behavior.

2. *Temporary and Inseparable Association.*—Another mode of association refers to the relative permanence of the connections when formed. Probably most of these connections when made between stimuli and responses or between stimuli persist indefinitely, although some associations become dissolved in the course of a longer or shorter time. Every case of forgetting or the loss of skill of any sort involves the dissolution of some connection between associated members whether responses or stimuli. Language connections exhibit many illustrations of inseparable associations which apparently should be dissolved. Thus sunrise and sunset persist as names for events which we know do not occur. Again, the expressions about the lack of brains or good brains survive in spite of intelligent information concerning psychological activity. Every person who is troubled about his own or some other person's bad habits knows the difficulties of disconnecting reaction associates.

3. *Original and Formed Associations.*—Of the connections between responses some are original associations necessary for the occurrence of given adjustments to stimuli. As such we may mention the movements constituting the combina-

tions of reflexes and the integrations of response factors in habits. Among the formed associations we may classify the organization of series of responses as nonsense syllables and various language connections, although in some cases of language reactions, notably where articles are inseparably connected with names as in the German language, we may consider such associations as original. The criterion we are using in this particular classification may be considered then to be (1) the degree of deliberateness with which the associations are formed when the individual forms them, and (2) the question whether the individual is responsible for the connection or whether the adjustments are socially dictated.

4. *Logical and Conventional Association.*—A fairly broad and sweeping distinction can be made between logical connections existing between responses and stimuli, and those based upon pure convention. Most associations which we form through the direct influence of the stimuli-objects themselves will illustrate the logical type of association. When we jump out of the path of an automobile we may justify speaking of such a response as a logical adjustment to the stimulus. Quite otherwise is it with another large mass of our responses. Attaching a sex name to a ship or gun is in no sense a logical association but merely customary. The domain of language is full of such illustrations of the logical and conventional associations. This distinction of logical and customary connections is likewise illustrated in our responses to sound. We speak of high and low, hard and soft tones, when as a matter of fact the names or descriptions given to such sounds are arbitrary and in many cases illogical.

5. *Direct and Indirect Association.*—As our last mode of association we may name the direct and indirect connections. As direct we may consider any immediate connection of associational members usually made possible by the fact that the person is in direct contact with the stimulating object when stimulus-response connections are formed. On the other hand, indirect associations are such as involve the intervention of a third factor when two members are associated. Direct associations are exemplified by the infant's

development of a withdrawal reaction by being burnt in the candle flame, while the indirect association is exemplified by acquiring informational responses to a foreign country by means of a geographical atlas. Indirect language associations are illustrated by the names we give to objects because of a resemblance in appearance, use or sound. Thus, we use the word glasses for spectacles, binoculars, or drinking glasses. Possibly the largest number of our indirect associations involve language and informational responses, for notice that all fixed figures of speech involve the indirect mode of association. When the indirect associations are not linguistic we find that in most cases they are formed because of the inaccessibility of the objects; so that the original contacts with them are brought about by reading of them or indirectly hearing about them.

Our discussion of these five modes of association offers conclusive evidence of the fragmentary character of the enumeration. Not only is it not practicable to enumerate all of the modes of association, but even in these five there is much overlapping. Again, it is not easy to hit upon a single criterion or even a few criteria upon which to base the enumeration. And so we have not attempted to distinguish between individual and social association, or between the formation, existence, and use of association. Just why an exhaustive inventory of all or most of the modes of association falls without the limits of wise undertakings, is found we believe in our much reiterated remark that association as a psychological process is a universal factor in all psychological behavior.

VII. *Levels of Associative Formation.*—From the fundamental and pervasive nature of association we may readily infer that the connections between the organism and its stimuli, as also the organization of responses themselves, take place upon every conceivable level of activity. If we start with the earliest elementary forms of connection between stimuli and responses such as constitute the basis of differential behavior and psychological activity in general we may say that the lowest association level is found in the biological

maturation of the organism. As a definite example of associative connection at this level we may proffer the case of reflex action, for we believe that the organization of response factors for the most part takes place during the intrauterine life of the person. Also, we might indicate, although this point is not wholly without ambiguity, that in the early weeks of postuterine development the connections between reflex acts and their stimuli take place.

To consider now associations formed during the individual's more active contacts with his surroundings we may note that many of them are developed without any intention of the person and in many cases without his knowledge. Illustrative of such situations are the cases of the infant who forms all sorts of reactional connections with the objects stimulating him besides acquiring many language responses through contact with persons who use that language. In both cases the infants may be said to have the associations made for them although they are by no means passive participants in the situations.

On the other hand, in active learning of all sorts associations are formed with the knowledge and consent of the person. At this level the individual is far more active in the organization of responses to stimuli or in the formation of connections between acts. When we learn to drive an automobile or operate any kind of new mechanism, or when we attempt to acquire any kind of book learning, we deliberately form associations for our own purposes.

Possibly the most complex and highest level in the formation of associations is the critical one of science. Here are developed the most definite forms of associations between the investigator and the objects which he studies. Because of the scientist's interest in the causal connection between things he must make abstract and very indirect associations. Clearer appears this point from the observations of things or inferences from those observations. Many scientific associations are of course the symbolization of the connections which the scientist discovers to exist between objects and events in nature. But in equally as many cases the relations between

things are so obscure and difficult to get hold of that a very indirect method of knowing them must be utilized.

VIII. *General Conditions of Association.*—Besides the specific conditions for the formation and operation of association which our discussion has brought out, a number of general conditions determine the kind, number and strength of connections which are formed.

Obviously, one of the most prominent of the general conditions must be the opportunities to form associations. In other words, the larger the number of our contacts with objects the larger is the number of reactions we build up with which to adjust ourselves to them. Likewise the greater the variety of things and events which affect us, the greater will be the number and types of our associations. Practically speaking we must, in order to develop many and various associations, visit new surroundings or have them brought to us through descriptions.

An equally influential condition for the formation of associations consists in the social surroundings of the person. The customs of the groups in which one lives are potent determiners of the behavior development of the individual, prescribing as they do what one shall learn, as well as determining what we must and must not do.

For the operation of association much the same conditions prevail. The more objects we are in contact with which can serve as adjustment or substitution stimuli for responses which we have acquired, the more likely is it that the responses will be elicited. And let us not neglect to consider the effect of the present attainment of the person upon his association formations. Skill and knowledge reactions depend for their development upon the present information and ability of the individual. We all know that the more information one has upon any subject the easier it is to acquire more. Similarly, the acquisition of specific sorts of associations develops a line of less resistance for the further development of associations in that general direction; the ground is prepared for definite interests and urges to do certain things and to develop desired behavior connections. On the other

hand, such acquisitions inhibit and interfere with the formation and operation of certain other associations. To possess particular prejudices means we will be prevented from indulging in certain activities and acquiring associations of specific sorts. The inhibitory effect of previously acquired associations even goes so far as to prevent us from performing actions which under the circumstances would be especially desirable or effective.

Of no slight importance for the formation and operation of associational connections is the general health condition of the person, and this extends to the matter of fatigue also. These points, however, it is unnecessary to stress, since they are operative with equal force in all cases and in all phases of behavior.

Manifestly, a general condition for the development and use of associations is practice. Without practice the acquisition and fixing of skill and informational responses would be an impossibility and certainly when associations are formed their use is greatly facilitated by constant and frequent exercise.

Finally, we have to consider the normality of an individual with respect to his associational reactions. If for any reason he is below par in his functional capacities he becomes disoriented, that is to say, his associates become dissolved and he loses contact with his surroundings. As a record of fact, the dissolution of association which we call disorientation is one of the most prominent symptoms of psychological disorder and disability. From the nature of association this is, of course, precisely what we would expect. In many cases, too, the disorientation may be owing to the stimuli factors, with the consequence that it is entirely possible that the disorientation or the lack of associative connections is itself the abnormality. Hysterical blindness, deafness, etc., are dissociations of this type, although they are frequently connected with other untoward conditions of the person and are not the result entirely of overwhelming external circumstances.

IX. *Psychological Association and the Neuronic Theory.*—Perhaps as a final indication of the character of psychological

association we might make clear the point that the process of association refers exclusively to the immediate or mediate connections between the acts of the person and surrounding stimuli. The term mediate connection refers to the associations in which series of responses are connected of which perhaps one or only a few members are in direct linkage with stimuli. What we wish especially to make plain is that the stimuli and responses are the end and sole factors in association. That is to say, association consists of the various organizations of these factors. What follows then is that we may not think of the connection between stimuli and responses or between responses and responses as the manifestations of something else.

Frankly, we want to deny that the connections between associational members are the manifestations or effects of connections between neurons or neural patterns. Further, we might go in our disavowal and say that we cannot accept anything of a neural basis for association. In opposition to the neural theory a number of objections may be strongly urged.

In the first place, to assume a neural basis for association means to distort associational facts in two particulars. (1) The function and efficiency of the stimulating situations and objects are set aside and not given place or prominence in the description of the associational facts. Besides preventing us from correctly describing the facts of association such a procedure inevitably misleads us into limiting the number and varieties of association to accommodate the theory. It is not improbable that to the neural theory may be laid the charge of excluding from associational types all the connections but those of ideas and sensations.

(2) No less serious objection to the neural theory is the criticism that its upholders attempt to make some phase or a part of one of the members of an associated couple a causal condition of the connection. More and more widely recognized is it becoming that we must not look upon the neural phases of psychological action as anything but integral factors of a total reaction. Now it is plain enough that even

when we are discussing associations between reaction couples we blunder by taking the neural components of one or both members as causing or conditioning factors. How much more culpable is it then when one or more members of the associated complex are stimulating objects or situations. Precisely how serious is this present criticism may be judged from the fact that when we maximize the importance of the neural factors in behavior we thereby submit the reactions to needless diremption, separating the neural activities from the many other components. And usually we follow up such descriptions by calling the neural mechanism an intervening process between the stimulus and the response, the response here being of course the remaining processes of the single adjustment act.

(*b*) Further, from the standpoint of an organismic psychology, the neural theory of association stands condemned because it perpetuates the doctrine of autonomous mental states. Instead of allowing psychological phenomena to be described as definite concrete reactions of the individual to his surrounding stimuli, the neural assumption presupposes that psychology is dealing with mental or psychic states for the existence of which the nervous system provides a basis and for the organization and operation of which the nervous system constitutes the mechanism. Whether we accept or reject a psychology of mental states we still face the problem whether the process of association is confined to the connection of simple units of a complex mind or state of mind, or whether the process includes also the connections of responses with stimuli, an addition which may be expanded to include the general interconnection of persons with their surroundings. A crucial problem is here involved affecting the very foundations of psychological science.

(*c*) From the actual development of psychology we learn that the insistence upon a neural basis and mechanism for psychological association involves a very doubtful procedure, namely the attempted correlation of specific neural elements with particular ideas or other mental states. How manifestly erroneous such a procedure is, is readily indicated by the

denial of every psychologist that he is really attempting such a correlation. No psychologist, it is safe to say, would care to admit that he means to connect an idea with a specific neural element; but is this not the inevitable implication of a neural theory? From the earliest correlation of neural and mental phenomena the aim of psychologists has been to make use of the neural apparatus to account for the organization and association of mental states; and how, we may ask, could this desired effect be brought about unless specific neurons were connected with specific mental states? Of a certainty this entire procedure is very vague and without the slightest shred of support from competent neurologists, and yet the aim of the psychologists although denied by them is indubitable.

What follows if the psychologist does not attempt an exact correlation between neural and mental elements? Simply this, that the nervous system is clearly neither a mechanism nor a basis for association or any other kind of psychological process. As we have more than once indicated, the neural theory not only does not help us at all in the interpretation of associational facts but it precludes our investigating the neural mechanisms themselves as integrant factors of complex reaction systems.

X. *Summary.* — Precisely as in the case of an earlier psychological period associational processes today may be looked upon as fundamental and universal mechanisms for all psychological phenomena. But unlike the earlier period in which association was considered as having to do only with mental states, we must today consider it as referring to the organization of actual stimuli-response situations. Associational processes, then, we may conclude constitute some of the basic facts in an objective and naturalistic psychology. We have attempted to point out that the specific reactions to stimuli such as we call learning, remembering, thinking, and the manipulation of skill are all the operations of connections between stimuli and responses. Also, psychological capacities of various sorts besides specific responses may be looked upon as the association of many responses and stimuli

of some given type, all of which in their operation give the person a series of general competencies serviceable in his various adjustments.

Now just in this fact that we can find common ground in such apparently widely separated psychological positions as associationism and objective psychology do we find support for the validity of our hypothesis that association is a fundamental basis for all behavior. Let us observe that after all the associationists may be considered as having magnified a single kind of associational process, namely connections between implicit responses. Our study, however, has sufficiently indicated that from an objective standpoint we must, along with the response factor, include the stimulus phase of a behavior situation as an essential factor also, no matter how many reaction systems are associated in a pattern of response to form the reaction phase connected with the particular stimulus. Since associational processes are in the last analysis orientation processes connecting the organism with its various surroundings, we must include among the types of stimuli studied the objects, events, and persons which arouse the individual to action.

Associational processes we have found to include always two phases, one the organization of stimulus and response connections, and the other the subsequent operation of the responses when the previously associated stimuli are presented. To a very slight degree then we might correlate the organizational phases of association with the simultaneous association and the operational aspects with successive associational phenomena.

Since we look upon associational facts as definite reactional processes we do not expect to find a few "laws" governing the operation of associational mechanisms. Innumerable contributing conditions accompany of course both the acquisition of associational connections and their subsequent functioning, but none of these is in any sense a directing principle of the connections between stimuli and responses. In contrast to directing principles or laws the conditions of association connection are the facts obtained in empirical

observation concerning some actual association. Similarly what we have called modes and levels of associations are designed to bring out specific empirical association features.

And finally, we conclude that if the facts of association are definite responses of organisms to their surrounding stimuli, then we can in no sense look upon any phase of the response such as the nervous apparatus as the cause or condition of the associational connection. In the first place, no such causal means of explanation is required to account for the facts of association, and in the second place, it would be impossible to give any causal explanation in terms of the neural mechanisms of the response factor. For our own part, we are content with our description when we give an account of the interconnection of stimuli and responses with the circumstances attending such an interconnection.

SENSATION, IMAGINATION AND CONSCIOUSNESS[1]

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Our scientific concepts generally are in the melting-pot. They are all infected by relativity. This is as true in psychology and philosophy as in the physical sciences. In each case we must be willing to reconstruct our concepts on the basis of new evidence. Psychology has too long been hampered by a false tradition, and incidentally it has dragged philosophy with it into the slough of subjectivism. Brilliant discoveries in the realms of physiology and pathology throw new light on many of the fundamental concepts of psychology, spite of the fact that the investigators themselves have sometimes been misled by the old tradition. We are here concerned with their data, not with their theories. The evidence, as I interpret it, gives the death-blow to the old subjectivistic psychology. As regards sensations, the evidence shows, on the one hand, that their character is independent of consciousness; but, on the other hand, it equally disproves the assumption that the sense-qualities exist in the physical world just as we know them and independently of the organism. The evidence further shows that the centers of the central nervous system constitute a hierarchy of energy patterns, not storehouses or factories of content, sensational or imaginal. The content is due to lines of motion, connecting those energy patterns with the sense-organs. The processes of selection, suppression, and integration at the various levels of the nervous system are due, not to consciousness, but to the characteristic energy patterns of these levels. There is no reason to limit consciousness to any particular level, though we can have evidence of it only in connection with one type of pattern, viz., meaning patterns. What con-

[1] This paper was read before the Psychological Society of Cambridge University March 2d, 1921, and before the Philosophical Society of Oxford University, March 12th.

sciousness contributes in connection with the various energy patterns and their excitement is the bare fact of awareness. It is not an explanatory principle. Furthermore, so long as we regard the individual in the abstract, we do not require the concept of mind.[1] We can explain behavior in terms of neural patterns and their stimulation. It is only when we take account of social relations that we find it necessary to introduce mind. In neither case do we invoke consciousness as a principle of explanation. With this brief introduction, we shall now proceed to the examination of the evidence.

The Nature of Sense Qualities

In the annals of psychology nothing more heroic has been recorded than Dr. Head's subjecting himself to vivisection in cutting certain nerves that supply the superficial organs of cutaneous sensation.[2] The evidence thus arrived at has been corroborated by a mass of pathological cases, especially from the late war. The evidence is so familiar that it will only be necessary to state it in outline. The elimination of the functioning of the superficial organs strips bare the deeper sensibility and reveals its quality. These deeper organs of muscles, joints, and tendons respond to pressure and to pain. They furnish a fairly accurate localization in space. And it is they which furnish the impressions which when conducted to the cortical field, give us the sense of passive posture or three-dimensional space.

When recovery begins to take place, the primitive punctate or protopathic system becomes active and confuses the process of localization. The protopathic system responds, through its punctate organs, to pressure, hot and cold, and pain. But its responses are diffuse, massive and primarily affective. It informs us, not of the qualities of things, but of how stimuli affect the organism. It centers in the optic

[1] So-called individual psychology has as a matter of fact not been individual. It has studied the reactions of the group-individual, though it has ignored the significance of the group in explaining conduct.

[2] For a summary of the epoch-making work of Dr. Henry Head, with Dr. W. H. R. Rivers and other collaborators, see Dr. Head's article, 'Sensation and the Cerebral Cortex,' *Brain*, 41, Part II.

thalamus rather than the cortex. It is adapted for defensive withdrawal of the body, not for differential reaction having reference to the part affected. Its responses are crude and non-discriminative. It is characterized by the 'all or none' reaction. It responds to extensity of stimulation, not to graduated intensity. Nor does it respond to localized stimulation. The stimulations radiate to distant parts. They lack control. It cannot discriminate the two points of the compass. It is different when the healing process is complete and the epicritic system appears. This superimposes control upon the crude mass response of the protopathic system. The sense stimulation no longer spreads to distant parts. We can now project points, *i.e.*, respond to the locality stimulated. The 'all or none' type of reaction disappears and the response is approximately graded according to variations in intensity. We can now take account of the physical qualities of things as well as the affective qualities. We can discriminate simultaneous and successive points in two-dimensional space. Adaptation, which is absent on the protopathic level, returns. All this of course presupposes the intactness of the central nervous system. The epicritic system is ultimately centered in the cortex, as the protopathic in the optic thalamus.

The sense-organs are characterized by structural differentiation, and upon their reaction to external stimuli depend in the last analysis the different sense qualities. We cannot follow the assumption that these qualities are merely transmitted from the external world. If we compare the sense organs to resonators, they are at any rate not neutral resonators, but contribute a differential quality of their own. They are specific energies. The cold spots will respond to temperatures below 22° C. with a characteristic cold quality. But they will also respond, in the absence of inhibition from the hot-spots, with an ice-cold sensation to temperatures of 45° C., which when applied to the hot-spots or the general surface give us a sensation of pleasant warmth. In the absence of the functioning of the cold-spots, the hot-spots respond to stimuli of 22° C. with a characteristic warm

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sensation. Sensations, in other words, are compound energies. They depend, to be sure, on the character of the stimulus, but they depend also on the energy complex of the sense-organs. This is especially evident in the case of the chemical senses which at any rate include all but hearing, if not the latter. It is as absurd to suppose that the physical vibrations, which our physical instruments reveal, are red or green, as to suppose that they are cold or painful. It happens that we carry a polychromatic camera in our heads. But we can also construct polychromatic cameras that can see colors. Neither the cameras in our heads nor the artificial cameras can see color unless they possess the specific energies to respond in a characteristic way. Sensations are ordinarily physico-physiological processes, though they can, under certain conditions, be produced by the organism independently of the physical stimulus. We have no evidence that they can be produced in the absence of the specific conditions furnished by the sense-organs or similar organs. Even in the case of sound, though we carry a harp in our ears, be it the basilar membrane or some other organs, we know that harps respond with a quality of their own. Sounds, too, are compound energies.

While we hold to the specific energies of the senses, this does not mean that sensations are transmitted to the cortex just as they result from the reaction of the senses. The evidence of Dr. Head and others shows that the crude sensations undergo selective analysis and new integrations on the way to the cortex. This, however, does not necessarily mean a change of specific quality. We are not in a position to dogmatize about the difference which the various neural patterns make to the sensory impulses as they are permitted to pass the hierarchy of 'vigilances.'[1] But, at any rate as regards the cortical field, pathological evidence goes to show that there is no raising of the threshold unless the cortical injury be very extensive. The difference between the normal reactions and the pathological may be reduced to one of

[1] The term 'vigilance' as used in this connection by Dr. Head has no anthropomorphic significance.

'clearness.' There is a lack of 'clearness,' 'pointedness,' 'sharpness' in the case of a cortical lesion affecting certain parts. This leads to uncertainty, hesitation, guessing, and hallucination. It is a failure in discrimination or a difference in attention. What holds on the cortical level probably holds in the case of the neural levels below it and their pattern reactions. In any case there is no reason to suppose that the characteristic qualities of sense-impulses are altered. And what is true of sense-impulses, holds equally of affective qualities. While the optic thalamus seems to be peculiarly the center of these qualities, the discrimination of intensive graduation within these qualities and their weaving into the complex patterns of emotions and sentiments, with their objective reference, must be peculiarly the work of the cortex. In any case the affective qualities do not owe their nature to consciousness.

Selection and Integration in Terms of Neural Levels

If the evidence disproves the subjectivistic interpretation of sensations, it no less breaks down the subjective view of the selection and integration of sensations. We can state the selective and integrative functions in purely physiological terms. They are present at all the levels of neural reaction and do not, any more than the data, owe their character to consciousness. We can thus give a physiological statement of the 'subject-object' relation. For the subject relation means the selection of data with reference to certain ends, whether these ends are ingrained in our nervous structure as a result of biological heredity or are further elaborated in terms of the life history of the individual. Obviously the first subject reactions must be biological, as individual history must start somewhere; but throughout individual history our selective activity is fundamentally determined by biological patterns, however much overlaid by individual experience. At each level of the nervous system, selection is conditioned by the unique neural pattern of that level as it is organized in terms of race and individual history. The object consists of the afferent impulses which are selected

and integrated by the pattern, or rather hierarchy of patterns, and which thus become effective in guiding conduct. The afferent impulses may figure as part of either the subject relation or object relation. They are part of the object relation when they are selected as data to be integrated and acted upon. They are part of the subject relation in so far as they are the rebound of the selective activity and figure as part of its tension, as for example the motor sensations in active attention. They become, then, means of selection, not data which are selected.

Let us now try to make our meaning clearer by examining the functions of the central nervous system at various levels. The nervous system consists of a hierachy of fields of energy or controls. These fields must be thought of in physiological rather than in structural terms, though of course they have structure. The structure, however, is too complicated for us to follow its internal dynamics. It is fraught with a past of indefinite duration of which we know little. We must therefore be pragmatic and judge neural structures by their functions. While these energy fields differ vastly in complexity and in their characteristic patterns, they have certain essential characteristics in common. Their part is to select, sort into kinds, suppress incompatible impulses and facilitate compatible, and finally redirect or integrate these impulses so that they may be carried out in accordance with the needs of the organism. Their adaptation throughout is of the trial and error kind; and it is clear that natural selection has acted effectively to eliminate the conspicuous failures of nature's experimentation, even though natural selection as a purely negative agency is barren so far as producing adaptation is concerned.

The sorting process begins at the first synaptic junction in the spinal cord. The sensory impulses of hot, cold and pain cross to the other side and travel along separate secondary paths. The tactile impulses travel both along the posterior columns and along secondary paths as far as the top of the spinal cord before they all cross into secondary tracts. Like impulses are grouped together from all three systems—

epicritic, protopathic, and deeper sensibility. Thus the tactual sensations from the three systems are combined. Impulses of hot, cold, pressure and pain proceed along separate paths to the optic thalamus which is the center for the crude discrimination of these sensations, but especially the center for the affective qualities of comfort and discomfort. The three sensory qualities of space are bound up with the tactile impulses along the posterior columns of the spinal cord; but above it they follow each a separate path through the fillet of the optic thalamus to the cerebellum and cerebrum.

The cerebellum has to do with the control and regulation of the postural and tonic aspects of muscular activity which involves complex discriminations and adjustments, though we do not ordinarily associate consciousness with such activity. The cortex is the organ of objective cognition. On it depend, in the first place, the more delicate discriminations of data. It is only at the cortical level that we discriminate graduated intensities of stimuli. It is also the supreme organ for spatial discrimination in the three dimensions—point localization, discrimination in two-dimensional space, such as the two compass points, and the sense of posture. The last implies a cumulative sense of positional values, or what Dr. Head calls a schema, which, however, must be understood as a cortical pattern reaction and not a contribution by consciousness. The cortex discriminates the physical qualities of size, shape, weight, and texture and makes graduated comparisons possible within those qualities. It also has the capacity of recognizing a series of minute and vibratory differences, thus giving us our immediate sense of duration. With the recognition of sense differences goes the projection of lines of reference to the parts affected, without which the information conveyed would be of no practical value, and this capacity depends primarily upon the cortex.

Imagination Patterns and Sensations

The cortex is not only the great organ for objective discrimination but also the great organ for establishing relations between data. For this complex pattern reaction of

the cortex, we may use the term meaning. Pathology[1] indicates a considerable specialization within the cortex for meaning reactions. The meaning of single words or names may exist when the propositional meaning of words is lost and *vice versa*. Both kinds of meaning are lost in deep semantic disorders. Meaning to a certain extent may exist spite of failure of verbal expression. The patient may still be able to point to things signified. However crude such recognition in the absence of language expression may be, it should give us pause from identifying meaning entirely with language mechanisms,[2] valuable though the latter are as instruments of meaning and indeed indispensable for its abstract elaboration. There is of course ample evidence for language mechanisms taking the place of thought, but then we no longer have the process of thinking.

It is evident that the great superiority of the cortex lies in the perspectives which the meaning patterns make possible. As it is equipped with the 'long distance receptors in space,' especially sight (as pointed out by Sherrington), so it is equipped with long distance receptors in time. While in the lower centers, such as those of the spinal cord, the past endures as condensed in their present structure, this responds only to present stimuli. The cortex, on the other hand, through its memory patterns can respond differentially to distant events in time. Again, through its anticipation patterns, it can project events into the future and build the bridge before coming to it. This hierarchy of relation patterns in the cortex, from the comparatively passive revival of past experience to the active reconstruction of experience to meet new events we shall call imagination. It is not necessary for our purpose to distinguish between imagination and thought. Or rather thought is one type of imagination. It is constructive imagination as contrasted with reproductive, though sometimes we limit thought to constructive imagina-

[1] See Dr. Henry Head's article, 'Disorders of Symbolic Thinking and Expression,' *Brit. J. of Psychol.*, 11, Pt. 2.

[2] Professor John Watson in his brilliant paper, 'Thinking and Language Mechanisms,' before the Oxford Congress of Philosophy, 1920, seems to identify thought entirely with language mechanisms.

tion which works with abstract symbols. This distinction has tended perhaps to draw the line too sharply between thought and artistic invention. Thought may work with concrete imagery, while artistic imagination may be singularly lacking in such material.

What I want to emphasize is that constructive imagination or thought is as genuine a type of neural pattern as is the reflex arc or the primitive instinct. In the absence of its specific cortical pattern, thought cannot be aroused any more than a reflex can be aroused in the absence of the specific neural pattern. You cannot make an idiot think, try as you may. Thought is not an instinct, as Graham Wallas intimates. It is a far more complicated pattern. It may be aroused by curiosity or any other instinctive activity; it may also be aroused by sensations. But it may act from its own peculiar restlessness, one thought process stimulating another. Thought is not to be regarded as a beast of burden of our lower propensities, as the anti-intellectualists maintain, though it may be evoked, and should be evoked, to guide and control the instincts. It may, however, work for its own creative satisfaction. Its bodily expression varies with temperament. It may be organic as in what Fouillée calls the 'sensitive temperament'; and then one can think best by lying flat on one's back; or it may be motor, and then one can think best by giving the large muscles play. It is essentially social, and so implies the need for expression of which language is an instinctive neural pattern.

And now we must say a word about images. The pathological evidence indicates that images play at most an unimportant part in behavior. Postural images may be present as vivid as ever in a cortical lesion on one side of the cerebrum, but such images are impotent to guide postural adjustment. They lead neither to effective recognition nor appropriate expression. Evidently images have been much over-rated by traditional psychology. But what are they? Since Galton there can be no doubt that there are marked differences in concrete types of imagination, *i.e.*, in the relation of imagination patterns to the different organs.

Some peoples' imagination relates more to the eyes, others' to the ears, etc. But this does not mean that the cortex fabricates a peculiar content, whether sensations or images, nor that it stores content. There is no more reason to suppose that the cortex stores or fabricates content than to suppose that the spinal cord does so. The neural centers of the various levels are systems of energy patterns of increasing complexity and uniqueness. They are not store-houses of content. What they store are lines of motion as potential energy. All content is sensational and exists only in the degree that the senses are active. All the real evidence points that way.

In the first place, it is impossible to distinguish between imaginative content and sensational content at the minimal level of intensities. This is what gives rise to the troublesome complication of 'expectant attention' in our experiments. If imaginative content had a unique quality, as some maintain, this confusion should not exist. We should no more confuse an image with its corresponding sensation than we confuse color with pressure, even at minimal intensities. In the second place, much at least of what has been supposed to be imaginative content is proved upon inspection to be sensational. This is particularly obvious in regard to motor imagination. But there is good reason to believe that it holds of all the types of content in imaginative activity. In the third place, we can arouse *bona fide* sensations through imagination. Imagine yourself riding on the back of a tiger, and you will find that you have veridic sensations of shiver all over. To a certain extent you can control the succession of color fields in the case of visual imagination when it is directed to producing color fields on the retina, and some experimenters claim to have complete control. Moreover, if you extrovert your attention in the case of a vivid visual image, you will find it on the retinal field. At least that has been my experience. Of course the pattern is cortical. A Scotch plaid would not happen by chance on the retinal field.

The anatomical mechanism, by which such sensational content is furnished, in the case of imaginative activities, is

obscure for the most part. In the case of motor imagination the sensational content is sufficiently explained by the close connection between meaning patterns and expression patterns in the cortex. The sensational content is the afferent result of this arc. But we cannot see how the motor adjustment of the eye could give us anything but motor sensations. It could not account for the variety of visual patterns that imagination furnishes. And the same problem meets us in the other sense departments. There is, to be sure, a close connection between incipient articulation and internal hearing, but it hardly seems sufficient to account for the range of auditory values of a symphony, considering the limited range of our vocal organs. They couldn't very well supply what they cannot produce, though they no doubt are contributory. It has, however, been definitely proved that there are centrifugal sensory fibers running from the sensory centers of the cortex to the sense organs as well as centripetal sensory fibers from the sense-organs to the cortex.[1] Such centrifugal fibers have been found where they seemed least likely, viz., in the ear. We have here, it would seem, the required physiological mechanism to account for imaginative content.

We may hold, I think, that the imaginative patterns in the cortex are connected by lines of motion, centrifugal as well as centripetal, with the sense-organs of the body; that what is stored is not content but lines of motion, thus connecting the meaning patterns with the parts of the body; that imaginative revival means that these energy patterns are brought into play and communicate their motion outward to the sense-organs, which if the excitement is sufficient to overcome their inertia respond by sending sense impulses to

[1] 'Outlines of Psychology,' O. Külpe, trans. by Titchener, 3d Ed., 1909, pp. 84, 85. The evidence in regard to the eye to which Külpe refers has since been corroborated and extended to the other senses. Külpe uses the hypothesis of centrifugal sensory conduction to account for (1) the effect of inadequate stimulation upon the brain-stem; (2) the phenomena of after-sensation, *e.g.*, that an exclusively monocular stimulation gives rise to a sensation in the unstimulated eye; (3) the so-called positive after-image, a secondary sensation of the same quality as the primary sensation but occurring after a short pause; (4) certain facts in connection with 'centrally excited' sensations, such as illusions and hallucinations. He still holds to the hypothesis of cortically excited sensations, independent of the periphery, for the ordinary imaginal processes.

the cortex. Unusually high excitement in the cortex would tend to produce illusion and hallucination. We can thus account for the proof-reader's errors and for our supplying the pianissimo treble notes which the player only feigns supplying; and we can understand why people see life-size ghosts with clothes on, just as they expect or fear they will. Individual variations of permeability in the direction of certain sense-organs would account for the relative dominance or absence of certain types of imagery. The fact that images do not ordinarily come ready made but are the result of fixation by attention, voluntary or involuntary; that, moreover, they increase with attention in vividness and definiteness until they result, as they often do, in veridic, and not merely nascent sensations; that under such circumstances, if we are careful observers, we can notice a corresponding excitement in the sense-organs—all this fits in with the above theory. Cases of insistent images can be shown to be due to an insistent cortical pattern which has established unusual permeability for itself in a certain sensory direction. We can account for negative after-images, resulting from imagination, which, however rare, are now acknowledged to be veridic, *i.e.*, some observers in imagining red have succeeded in getting a negative after-image of green. The theory would also help to explain various phenomena of centrally initiated pain sensations, so familiar to the pathologist. But the psychological reader can easily multiply instances where the theory would be useful.

It is not difficult to account for what has been termed imageless thought on the above theory. In the first place, there is wide variation as regards the presence of concrete imagery and in some individuals it is largely absent. But further than that, when the attention is absorbed in the search for abstract relations, there is a tendency to suppress the revival of sensational impulses, for these might confuse rather than increase the effective working of attention. The law of economy operates to suppress the useless and to emphasize that which tends to further the end involved. It seems, moreover, that a continuous tendency to suppress

concrete imagery leads to atrophy of the functions of revival in that direction or, in other terms, tends permanently to block expression of that type. We recall as a familiar instance of this the regret expressed by Darwin in his later life that he was no longer able to enjoy music or poetry which had been an important part of his life in his earlier years. Coupled with this regret was a feeling that such loss of concrete appreciation had probably caused a deterioration of a moral kind.

It has been suggested as an objection to the above theory of imagination that people who have lost an arm or a leg still have the feeling of a 'phantom' arm or leg, which, according to some, seems shrunk and smaller than the other. The evidence is by no means unambiguous, but it would seem that in such cases it is visual imagination and not tactual which furnishes the pattern. Dr. Head has shown that the image of the phantom limb, which may exist in cases of lesions on one side of the cortex, has no value in recognition or postural adjustment. If the patient's affected hand is moved after his eyes are closed, and he is asked to indicate its position, with the other hand, he will point to the place where it was when he saw it. As to the sense of shrinkage or shortening, that would seem to be a matter to be interpreted in terms of tactual sensibility. Since the sensational response to the projected sensory lines is actually cut short and shrunk in bulk, the fact would be just what we should expect on the theory we have advanced. On the other hand, if the sensory processes are cortically produced there seems to be no reason for any shrinkage. Another objection which has been raised is that persons whose eyes have been removed, including the retina, still have visual imagination. It is necessary to have more definite facts before attempting to answer such an objection. In the first place, the term image has been and is a very ambiguous word; and it is therefore difficult to know what people mean when they speak of an image. There would still be meaning patterns directed towards the eyes, though there were no concrete imagery. Again, the actual facts of the operations

would have to be established. In the nature of the case there could be no objective test, and the introspective test must always be uncertain. Furthermore, we are under a peculiar difficulty in the case of the end organ of vision, owing to its being, as it were, a projected part of the cortex. We cannot be sure how much is included in the organ of vision.[1] But in both of the above objections the facts are still too much in the nature of old wives' tales to be taken seriously; the important thing is that the theory should meet the ordinary and established facts.

Suppression and Neural Levels

The sorting and integration of sensory impulses would be useless except for another function of the nervous system, viz., that of selective inhibition or, to use Dr. Rivers's term, suppression. A certain 'vigilance' is exercised by each neural level which permits only those impulses to pass which fit in with the general set. There is a constant struggle for dominance amongst incompatible impulses at the various levels. Were all allowed to reach the highest level of discrimination, there would be endless confusion. But only the victors reach the higher levels. Which among several competing impulses emerges as victor not merely depends upon the quality, intensity and duration of the preceding impulses but implies the entire history of the nerve-center,—the duration of previous lines of motion, whether of race history or individual history, as structure or potential energy. And we must take account not only of the set of the individual center, but of its relation to the levels above it which under normal conditions to a large extent control its behavior. Prepotency is, therefore, a very complex affair and can be studied by us only as revealed in function.

It is easy to illustrate the fact of suppression in connection with sensory impulses. Suppose you apply a metal disc of

[1] If in the case of vision the sensory neurones of some center or perhaps the receptor cells in the cortex itself have a differentiation corresponding to that usually attributed to the retina, then when the synaptic connections with the centrifugal sensory fibers are once established in the cortex, the centrally initiated motion would only need to travel to the synaptic junction of the centrifugal with the centripetal fibers next below the center in question to produce the required afferent current.

a temperature of 45° C. to the back of your hand. You stimulate not only the hot spots, but the cold spots, the pressure spots and the pain spots. Yet the sensation is one of pleasant warmth. The other impulses, under normal conditions, do not reach the cortex. This does not mean that they are absent. Pathological cases show us that they are always present, ready to come to light when the epicritic control is removed. Visceral sensations are always present, but it is only under abnormal conditions that they reach the highest discriminative centers, and this because their information becomes important for self-preservation. The suppressed sensations, moreover, may count, even when they do not reach the higher levels, in guiding reflexes of the lower centers.

It is, however, not only in connection with sensory impulses that the nervous system selects the compatible and suppresses the incompatible. The principle holds throughout. Dr. Rivers[1] has shown how within the cortical level there are various strata, due in the first place to organic evolution, with recapitulation in part at least of its main periods, but overlaid in the course of individual development. Here we have again the struggle for dominance of the various tendencies of the more primitive levels, on the one hand, and the epicritic control by the later levels, on the other. The earlier strata, such as the infantile level, the childhood level, the adolescent level, etc., do not disappear in the later life of the individual, but the crust of custom of the upper level exercises strict 'vigilance' over them, and we may not under ordinary circumstances suspect their presence. Their suppression may, however, very much complicate the life of the individual; and they are ready to assert themselves with excessive vigor when the ordinary 'vigilance' is relaxed. How to reduce the suppressed tendencies to a minimum by integrating them into a comprehensive scheme and sublimating them into the activities of normal life is a problem not only for the physician but for society at large.

[1] W. H. R. Rivers, 'Instinct and the Unconscious,' 1920.

Neural Functioning Illustrated in More Complete Reactions

Our emphasis so far has been upon the sensory and cognitive functioning of the organism. But we might have selected the more complete reactions with equal effect. The cognitive aspect does not exist by itself, but is bound up with the executive and motor aspects, and their complicated systems of patterns. The more thoroughgoing is the cognitive or informative function, the more definite and adequate is the affective or motor aspect. In the case of the reflex arc, the simplest complete neural act, we have the selection of sense impulses, the suppression of incompatible impulses, the integration of impulses into the prevailing pattern and finally the projection of lines of action to the part affected. This of course assumes the intactness of the central nervous system. In the conflict for dominance in the neural centers, the physical law of summation of forces, as Sherrington[1] points out, does not hold. When the flexor reflex and the extensor reflex conflict, the result is not an algebraical summation, but one or the other becomes prepotent; the other is suppressed. Orderly succession of adjustments means the supersession of one reflex or group of reflexes by another. It means the passing from one reflex pattern to another, determined in part by the quality and intensity of the stimulus, in part by the set at the time of the neural center,—this set being due to its previous stimulation and constitution on the one hand, and its relation to the higher centers on the other. Thus coördination is established as between reflexes, and the ends of the organism are furthered.

The simplest neural centers thus reveal the essential traits of group conduct. "The nervous system," says Sherrington, "is in a certain sense the highest expression of what the French physiologists term the *milieu interne*." [2] We may look at nerve-cells from three points of view. In the first place, we must take account of them as individuals. "Nerve-

[1] Chas. S. Sherrington, 'The Integrative Action of the Nervous System,' 1906, 112, 118.

[2] *Ibid.*, p. 4.

cells like all other cells lead individual lives—they breathe, they assimilate, they dispense their own stores of energy, they repair their own substantial waste; each is, in short, a living unit, with its nutrition more or less centered in itself." [1] In this respect nerve cells are like other living cells. In the second place, nerve cells present a high degree of contagion. "They have in exceptional measure the power to spatially transmit (conduct) states of excitement (nerve-impulses) generated within them.[2] When we approach the problem from the social point of view we find a similar relation between individual organisms. This phenomenon is especially prominent in the case of crowd excitement and certain artificial and pathological states. In the third place, the reactions of nerve cells have the function of integration. "In the multicellular animal, especially in those higher reactions which constitute its behavior as a social unit in the natural economy, it is nervous reaction which *par excellence* integrates it, welds it together from its components, and constitutes it from a mere collection of organs an animal individual." [3] The simplest level of conduct, that of the reflex arc, thus foreshadows the characteristics of the most complex levels of behavior, including the interactions of the highest organisms.

If we turn now to the instincts and emotions, we find the same fundamental functions of selection, suppression, integration, and projection. They have, as McDougall has pointed out, their cognitive, affective and motor aspects. Cannon[4] has shown that emotions owe their specific and unique character to their being neural pattern reactions, resembling in this respect reflexes such as sneezing, though of course vastly more complicated. "They are ingrained in the nervous organization," and respond "instantly and spontaneously when the appropriate 'situation' actual or vividly

[1] *Ibid.*, p. 2.
[2] *Ibid.*, p. 2.
[3] *Ibid.*, p. 2.
[4] See Walter B. Cannon, 'Bodily Changes in Pain, Hunger, Fear and Rage,' 1920, especially pp. 280–283.

imagined is present." They are, among the higher animals, for the most part cortical patterns, but Sherrington's experiments on decorticated dogs and cats show that 'at least one such pattern, that of anger, persists after the removal of the cerebral hemispheres.' We cannot, it is true, neglect expression as a factor in emotions. They 'gain expression through discharges along the neurones of the autonomic nervous system,' and in this way get what James called their 'bulk.' But the setting off of the autonomic system depends upon the intensity of the emotional stimulus rather than its specific character and could not possibly differentiate the emotions.

That the emotion patterns are genuine energy patterns is shown by their effect upon secretions and muscular contractions and by their stimulation of the adrenal gland which increases blood sugar in intense excitement. It is also shown in pain and great emotion by the 'hastening of the coagulation of blood' and in general by the 'energizing influence' which 'the fierce emotions' exercise.

The sentiments, again, as Shand[1] has shown, manifest still greater complexity of pattern. This is due in part to inherited connections between emotions. "Every primary impulse, whether it is independent or belongs to a primary emotion, is innately connected with the systems of fear, anger, joy and sorrow in such a way that when opposed, it tends to arouse anger, when satisfied, joy; when frustrated, sorrow; and when it anticipates frustration, fear; these symptoms being similarly connected together." In the case of such a complex sentiment as maternal love, the innate connections are immensely complicated. But the complexity of patterns increases vastly in the course of individual experience as the emotions become organized in terms of patterns of imagination and their objective implications. In general, "every sentiment tends to include in its system all the emotions, thoughts, volitional processes and qualities of character which are of advantage to it for the attainment of its ends, and to reject all such constituents as are either superfluous or antagonistic." The sentiments tend to form a hierarchy in

[1] See Dr. A. F. Shand, 'The Foundations of Character,' pp. 35–106.

which greater systems are superimposed upon lesser systems, including the bodily systems,[1] until a character is formed,—the more inclusive systems exercising 'vigilance' over the more primitive. They are in Shand's phrase, "forces; they work in certain ways and in certain directions. They are within us to perform certain functions."[2]

That the meaning patterns of the cortex are an integral part of the complex volitional arc and issue in certain definite motor patterns for the control of conduct is attested by the whole trend of modern psychology. The motor patterns owe their definiteness and control to the meaning patterns and in turn make them effective. No impression without expression is a psychological commonplace and holds of the cerebral levels as well as of the lower levels. Language patterns are only one form of this expression, though socially a very fundamental one. All the facts go to indicate that we must regard the nervous system as a hierarchy of energy systems with increasing complexity and interconnection as we proceed to the upper centers. Each level has its own quality or functions which pathological evidence has enabled us to dissociate from the total system.

We must not forget the integrity of the nervous system, when we talk about the reaction of nerve centers. It is a singular fact that the lower centers owe their definite and stereotyped functioning to the control of the upper centers. In the case of stimuli of high intensity, the control is broken; and then the lower centers act in an indeterminate and unpredictable way. When through accident the lower spinal centers become separated from the upper part of the nervous system, they respond by mass reflex and in other diffuse ways. They no longer project their response to definite points, but relapse to the old defensive reactions of withdrawal of the entire part of the body.

If it is true that the lower centers are dependent upon the upper, it is no less true that the upper are dependent upon the lower. This dependence, moreover, is not merely an execu-

[1] *Ibid.*, p. 27.
[2] *Ibid.*, p. 178.

tive dependence but concerns the whole life of the upper centers. We all know how deeply rooted are the instincts and emotions in the primitive reflexes of the organism. And the sentiments in turn are rooted in the emotions. But imagination, too, even in its highest stages of creative organization, is closely dependent upon the primitive part of us. I have in mind, not merely the serious complications of the sex life which often accompany intense work of the higher type, but the more positive fact that our higher activities draw their energy, color and zest from their aliveness to sense experience and the passions. This will no doubt be recognized with reference to the more sentimental imaginative activities, but it is true of abstract thought, too. No person who is a mere intellectualist is likely to make any profound discovery or to move the imagination of human beings. The really great thinkers are poets at heart. And it is when we *express* the emotions rather than when we *repress* them that thought takes wings, that creative imagination comes to free and momentous expression. Your dry as dust intellect may do valuable secondary service, but it is not likely to do first class work. You must have a *passion* for beauty or your fellow men or something greater than yourselves to sustain great thought. There is something almost infantile and primitive about genius that ensures youthful freshness to its work and makes its world a world of perpetual wonder. This is merely another way of saying that the great and fruitful intellect is not a mere cerebral language machine but lives clear down to his toes. All the levels are tapped and converge to give reality to his thought. The whole organism, and not least the despised parts below the diaphragm, contribute their vital share to the real life of creativeness. Your whole cubic capacity must be alive, to borrow an expression from William James, if you are to do your best intellectual work.

Consciousness not an Explanatory Category

So long as we limit ourselves to the individual organism and its implications, we can project all our facts on one plane,

viz., that of physiology, even though we are under the necessity of borrowing some of the terms that have been associated with psychology. In the first place, there is no need to take account of consciousness. We may regard it as a universal property. It is a fair assumption that it is present on all the levels, even though it is only on the cortical level that it becomes significant and therefore known. There are limiting cases of well-nigh pure perception in our experience, but these are remembered because they issue into processes which have meaning. Consciousness in any case accounts for no processes. These must be explained in terms of our reaction patterns and their lines of relation to the terminal organs which furnish our data. Consciousness is everywhere a neutral light. It is not consciousness that colors the processes. It is they that color it. It is not consciousness which gives unity to our energy patterns. It is they which give unity to it. Consciousness controls no reactions. These are controlled, in so far as they are controlled, by the system of energy patterns of each level and of the whole. Consciousness is therefore useless for explanatory purposes and we can cancel it, as we cancel a factor in an equation when it figures in the same way on both sides. To be sure, there is the fact which Alexander has called 'enjoyment'; but this owes nothing to consciousness except the bare awareness; and in any case the fact would not be patent in a solipsistic world. There are, of course, different levels of control with their conflicts and subordinations. It is true that the great mass of our life lies below the cortical attention level with which we usually identify our ego. But this complexity of levels and controls is in no wise explained by consciousness. I suggested some years ago the awkward adjective, subattentive, for the levels below the customary crust.

The concept of consciousness has long been a stumbling block to a consistent account of behavior. It has been felt that there is an impassable gulf between consciousness and physico-organic causes and effects. Huxley says: "How it is that anything so remarkable as a state of consciousness comes about as the result of irritating nervous tissues, is just

as unaccountable as the appearance of the Djin when Aladdin rubbed his lamp in the story." And Tyndall says: "The passage from the physics of the brain to the corresponding facts of consciousness is unthinkable." The answer is that there is no such passage. The physiologist in describing behavior in terms of physico-organic mechanism never runs across the fact of consciousness. It is not an energy category and therefore does not figure in the chain of causes and effects. It constitutes another dimension from energy at any of its levels, physical, organic or mental. It is not originated by energy changes, neither does it originate energy changes. It is therefore irrelevant to causal explanation. It is relevant only when we deal with the significance of behavior. And what it contributes is merely awareness.

Mind as a Social System of Patterns

If the study of individual behavior in the abstract does not require the concept of consciousness for explanatory purposes, neither does it require the concept of mind. It is entirely arbitrary to identify mind with any special level of the nervous system. All the levels, we have seen, have the same essential characteristics. They all discriminate, inhibit, reinforce, integrate, and project in accordance with their unique energy patterns and their relation to the economy of the whole. Individual psychology is an unreal abstraction and in fact is not psychology at all. It is a misnomer. We can, it is true, study the human individual as a system of indicative signs or implied meanings, just as we study geological strata or the life of plants. But this is behavior as the physiologist studies it and should be called what it is, viz., physiology.

The issue has been confused by the fact that psychology so-called has followed no consistent principle of explanation. When it has dealt with the more elementary processes of habit, emotion and sense perception, it has leaned on physiology or pretended to do so. When, on the other hand, it has dealt with the more complex processes, such as the sentiments, thinking and will, it has fallen back on social

psychology. It has as a matter of fact started with the adult behavior of the psychologist as differentiated, integrated and stereotyped through social relations, but has abstracted from those relations. Instead of treating of the individual within the matrix of social relations, under the control of which he acquires his habits, attitudes and perspectives, it has made him an abstract entity. It has forgotten that the world as it exists for the psychologist, with its things, qualities and relations, its values and attitudes, its play of free ideas and its organized will, is the product of social communication and interaction, made possible by a highly evolved language and tradition. The physiologist, who starts with the simple reflex of the nervous system and follows this through more complex levels of selection, integration and control, at any rate is consistent in his explanation. In the most complex behavior of the organism he sees the play of ever more complex mechanical causes. And though these may not furnish the sufficient reason of the behavior, they at any rate are an index of behavior and make a consistent story. If consciousness is present in this account it is at any rate irrelevant so far as explanation is concerned. It is assumed that the organic mechanism in its entirety,—neural, chemical, physical,—would indicate all the various complexities of behavior, could we follow it, which we cannot. At any rate, it is all we have so long as we deal with the individual organism in the abstract.

Mind is essentially a system of intersubjective meanings or valuations and of controls as resulting therefrom. We may speak of mind as a superorganic system of relations as we may speak of life as a superchemical system. In any case each is a unique type of energy system with characteristics of its own. In the absence of expression, mind is inchoate and ineffective. It can at best be regarded as potential from the spectator's point of view. The formative idea is the soul whether in the individual or in the group. And this is created in social relations and can only be understood through social relations. Mind comprises, it is true, relations to the physical world as well as to the social. But the former exist

as meanings only because they are selected and integrated into social patterns. The physico-organic concept of mechanism employed by physiology is itself such a socially constructed system of patterns and should be worked so far as it can be worked. But it proves inadequate when we come to deal with social relations. I may add in passing that it is not necessary that the formative idea or system of ideas should be conscious at all times. It is at most only partly conscious at any one time; and at times, as in sleep, it may not be conscious at all. The mental patterns are, no more than the neural patterns, dependent on consciousness for their existence, though they cannot have significance without consciousness.[1]

It is only when we are concerned with expressive signs, with social relations, that the concept of mind becomes necessary. Here we have a new perspective of relations, a new reading of the facts. We no longer deal with neural patterns except as instrumental to the new type of relations. We are concerned with a new type of energy field where will relations, the craving for association and reciprocal sympathy, the intention to express and to be understood, the desire to share in a common life become the important facts. We have to do with teleological causes—the realization of needs and interests in social relations. We are concerned only indirectly and instrumentally with mechanical causes and effects. Here we have selection, inhibition, facilitation, reinforcement and integration of conative impulses, obeying in the main the same laws that we have become familiar with in the physiological field. There is the grouping of like impulses with like, there is the struggle for dominance and the selective inhibition of the incompatible impulses, the facilitation of the compatible and their integration into a common direction by the controlling pattern or set of will relations. In this pattern, duration plays an even more important part than in the physiological patterns, for here we have the past conserved, not merely in the slowly formed patterns of bio-

[1] I have dealt more fully with the relation of the concepts of consciousness and mind in 'A Realistic Universe,' Part II., Macmillan, 1916.

logical heredity, but also in the cumulative tradition, embodied in language, art and institutions, and moulding the habits of each generation, through education and social sanctions, into conformity with itself. And we have the projection of the future, which is not merely the projection of the past but has a forward-looking implication—due to our being part of a larger cosmic order which we cannot understand but which somehow determines our course and our survival conditions. We have fusion, as in the orchestration of a vast number of musical instruments of varying timbre, of the various complex energy patterns of individuals and groups into a common tradition and a common life; and here, as in the physiological field, we have to take account of the quality, the intensity and the number of components as well as the total situation of the controlling energy field. This forms a continuum of a unique sort, cutting the individuals into various planes, protopathic or epicritic, according to the type of control and the situation at the time.

The fact that we are so organized that every instinct and emotion is provided with selective inlets or receptors for sympathetic response to corresponding instincts and emotions in others and that, further, we can only realize our nature and find our satisfaction in association with others goes to show that the evolution of life has assumed a new type of energy pattern in which the group is the unit rather than the individual, just as in the multicellular organism the organic whole becomes the unit of control rather than the cell. The types of group-unity vary all the way from the nutritive unity in the lowest stages of animal life, through the organic family of the bee, to organized self-planning society. The future is dark to us, but judging from human history so far and from our newly gained psychology of human nature, it would seem that if the race is to survive it must evolve a pattern of social relations which furnishes, on the one hand, a maximum freedom of individual human nature and, on the other hand, a maximum of sympathetic coöperation for common ends. Only such races as can meet these two tests are likely to survive in the long run.

Whether we translate the facts into mental or physiological terms, it is clear that we must explain behavior in terms of energy systems or patterns and their action, reaction and interaction with the energy patterns of the environment. We cannot on the social level, any more than on the physiological, explain behavior in terms of consciousness. The evidence shows that not only are the sense qualities and affective qualities independent of consciousness but the functions of selection and integration, or, in an older terminology, analysis and synthesis, must also be accounted for in terms of energy patterns—neural or mental according to our approach—and independently of consciousness.

The subject-object relation now becomes one of significant selection on the basis of past and future perspectives. With the aid of language mechanisms, meaning patterns, ingrained by heredity and organized by personal experience, function as judgments, expressed, supplemented and corrected in terms of social relations, present and past. Selected impulses now become data for conscious construction and reconstruction to meet the needs of life. And life includes pure thought. It takes delight in successful action, theoretical as well as practical. But in any case, the process is a trial and error process. The final test of proper thinking is proper conduct within the dominant purpose. This is as true in the realm of theoretical construction as in the sphere of practical judgment.

Mind patterns may express themselves not merely in immediate social relations, but also in forms of matter, institutions and language. A great genius may express his meaning in musical patterns of vast complexity like a symphony of Beethoven or in sculpture like the Zeus of Phidias. He may express his thought in the building of cathedrals or in systems of philosophy or in great epics. And these patterns, with the will communicated to them, continue to live in the history of the race long after the creator has passed away, thus giving his mind a continuous vitality in history for long periods of time—perhaps latent for centuries but always ready to spring into renaissance when the proper

conditions arise. It is so that English culture has been organized and continues to be organized through the ongoing genius of a Shakespeare, who in turn is ever reconstructed in the living tradition of the race. So Plato lives through the centuries and makes us Greeks, while we in turn give his genius the coloring and vitality of our time. Such influences are lines of motion entering into ever new systems, yet always retaining their individuality as the historic pageant passes, dwindles or grows, through the endless perspectives of space-time.

Having once been compelled to introduce the conception of mind in order to understand social relations, we can now return to the individual and study his behavior from the social point of view. Strip the individual of all social reference and nothing remains but a bare physiological automaton. But it is different when we consider the individual as part of the group. It is obvious that meaning and language are the articulation of the need for expression and reciprocal sympathy, *i.e.*, they are group planes which intersect individuals. Creative imagination, whether concrete or abstract, exists to organize and give form to this need for expression and mutual understanding. The sentiments are emotional patterns moulded upon social objects in the course of group relations. Even the instincts are all equipped with inlets for social sympathy. They are highly contagious. The cerebrum, in short, becomes an organ for social interactions, past, present and future, *i.e.*, it is an organ of mind.

As for the other neural levels, they too acquire new significance. It has been customary to start with reflex arcs and to judge the other reactions on that type. If we start with the assumptions of the physical sciences, it is natural to treat this arc as purely physico-mechanical. And having once made this assumption, there is no place where we can stop; and we are under the necessity of projecting the whole of conduct on the plane of the physico-mechanical. But we can now interpret the functioning of the lower centers from the social point of view. We can project the functioning of these centers on the plane of mind. They have their own

reality, their own contribution to make to the life of social relations. This fact is unfortunately overlaid and obscured in our artificial society. The cortex is preëminently an abstract language mechanism and its increasing tyranny over the lower centers, owing to extreme centralization of functions, tends to suppress unduly the more primitive functions. Under artificial conditions such as hypnosis and the spontaneous trance, and in the less abstract life of primitive peoples, we have an opportunity to observe a more immediate and more nearly protopathic sense of social relations which is largely suppressed in us except under conditions of extreme crowd excitement. The increasingly abstract epicritic control gives us our intellectualistic theories of individualism, so foreign to primitive society. We must, I think, presuppose an immediate protopathic sense (however overlaid and difficult to disentangle) of social presence which constitutes the sense of reality of social relations. It furnishes the primitive continuum which is canalized and overlaid by the later epicritic cognitive functions and only under unusual conditions rises into the attention-field. In genius there seems to be an unusual persistence of the protopathic type of immediacy and hence an unusual liveliness of the immediate and first-hand values.

The question may well be raised whether the extreme cortical centralization of the organism, with the consequent suppression of the primitive sense of rhythm, movement and concrete imagination, which is the course of civilization, is not a tendency to senility and therefore self-defeating. If the psychic attitudes make a difference, directly and indirectly, to the blood, and if the blood in turn makes a difference to the germ-cells, then it may well be that the absence of proper stimuli and interactions may cause certain tendencies in the germ-cells to atrophy or at any rate to make them available only under such exceptional conditions as to make them of little service. This should give us pause in our artificial and murderous civilization.

SOME UNUSUAL VISUAL AFTER-EFFECTS

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Delayed After-Sensations.—During the summer of 1918 a large map of the battle front in France was tacked to the wall of my room. Just before going to bed I usually traced the day's progress in various parts of the front on this map, moving the eyes slowly to and fro. The room was dark except for a movable electric light which, as I turned it, illuminated one part or another of the map. The map was of the sort that features swamps and forests as well as roads and boundaries.

Several times after studying the map for perhaps half an hour I undressed quickly and turned out the light. I then noticed in the field of vision (with eyes closed) rather distinct pictures which bore considerable likeness to the tracings on the map. There were networks of lines like the roads, and patches like the swamp markings. These pictures were not stationary, but moved slowly to and fro. At no time was there a recognizable reproduction of any part of the map.

I have noticed a similar phenomenon several times after reading at night in bed in a rather dark room with the page of the book brightly illuminated. After the light is out I see impressions resembling printed words and letters. These after-effects are not stationary, but seem to move very much as the printed page moves in the visual field in reading. I have never been able to identify positively any printed word. Occasionally there is a strong suggestion of some familiar word, such as 'the'; but I am never sure that the significant part of the impression is not supplied by the central imaging process. Occasionally when playing solitaire card-games in the evening I have had after-sensations resembling playing-cards after going to bed; the impressions are always too indistinct to identify any particular card.

The most satisfactory experience of this type occurred recently. I was examining under the microscope some slides showing sections of the cerebellum. It was late in the afternoon; the room was quite dark except for an electric standlight centered on the mirror and reflected through the slide to the eye-piece. On account of wearing spectacles the field seen in the microscope is comparatively limited.

I was observing the nerve cells and axons especially, and moved the slide slowly from side to side in a zigzag, so as to inspect the whole section on the slide. Three slides were examined in this way, for about half an hour. Then, being sleepy, I turned out the light and lay down on a couch; the room was in twilight darkness. I fell asleep almost at once and slept some 15 minutes.

On waking I looked at my wrist watch, but immediately closed my eyes. I was fully awake. In the center of the visual field I observed a small circular area of intense brightness, corresponding to the bright field of the eye-piece previously before the eyes. The rest of the field was dark. The bright field was filled with black spots, like nerve cells, which were supplied with long fibers like axons. The contents of the bright field moved slowly to and fro in a manner corresponding to the zigzag motion of the microscope slide. I observed this after-sensation very carefully for several minutes. The lighted area (about the fovea) seemed about as bright as the field of the original. The moving figures were very distinct, and were unmistakably similar to nerve-cell bodies and fibers. The entire impression was apparently peripheral; none of the significant features were furnished (so far as I can judge) by central imagery elements. While I could not identify any momentary impression as an exact reproduction of any definite portion of the slide, the arrangement of cells and other elements was strikingly like that in the original.

These moving after-sensations lasted about 15 minutes. I opened my eyes two or three times during the observation, and the after-sensations always returned on closing them again. An engagement prevented the observation from being

continued to determine its maximum duration. I wish to emphasize strongly the *definiteness* of the figures seen, their *motion*, and the fact that they appeared unmistakably of *retinal* origin.

Prolonged After-sensation of Glare.—Sometimes on a misty day, on going from daylight into a dimly-lighted room, a portion of the visual field lights up with a bright glare. Once this came on as I entered a physician's waiting-room, so that there was ample opportunity to observe its course. On this occasion the glare effect covered nearly half the field and was shaped like a circular disk. It was so thick that nothing of ordinary brightness could be seen through it, though the remainder of the field was perfectly distinct. A small clear spot was noticed within the blinded region, near the edge. This clear spot gradually enlarged and at the same time the blinded region grew smaller. The central clear spot finally reached the clear field at one place, so that the area of glare became crescent-shaped before it disappeared. The phenomenon lasted some fifteen minutes. The effect did not fade away, but the field cleared up from the edges. On another occasion the glare turned purple and quickly faded away. This time the room was quite light; the phenomenon lasted only two to three minutes. In no instance was there a definite objective stimulus to which I can attribute the glare. The effect is apparently due to some condition of the retina and to the general objective conditions of illumination. I have learned to expect the glare effect beforehand, when the eyes are 'dazzled' by a bright mist or something similar. It may be added that for years I have made a practice of observing ordinary after-sensations, so that I am able to prolong them considerably longer than is usual.

Involuntary and Voluntary Visualization.—As a child I had the capacity of arousing very distinct and vivid visual impressions. In our household family prayers were held daily. Time after time, with eyes closed, I observed the play of colors before me. The impressions often took the form of colored patterns, somewhat like kindergarten de-

signs. These patterns were continually moving or changing their colors or form. The effects were somewhat like those seen in a kaleidoscope except that the patterns were much more regular. They arose and changed of their own accord and were not subject to voluntary control. Often they were as vivid and clear-cut as actual sensations. These phenomena occurred from the age of eight (or earlier) to twelve or more, so that this report after forty years is of little value without corroboration. I am personally convinced that they were retinal phenomena.

Later I was accustomed, with a cousin of my own age, to try to 'see stories' with closed eyes in the dark. Whether the stories he told were actually visualized I cannot say. In my own case they were a sort of visual imagery, often quite vivid, but not so 'real' as after-sensations or as the patterns just described. Sometimes the changes were voluntary, at other times they seemed to be independent of every effort. So far as I can recall at this distance of time, the human figures and other familiar objects in these pictures were very distinct and detailed.

This cultivation of visualization continued till about the age of eighteen, when under a new environment the practice dropped away almost at once. For many years my visualizing capacity was little used and seems to have degenerated, although I worked considerably with visual after-sensations.

Within the past two years I have endeavored to renew the practice of visualizing with closed eyes. At first the results were meager; I saw only retinal light and fleeting after-sensations. Gradually the visualizing power has returned, and I am able to picture scenes voluntarily, though not so vividly as in adolescence.

I obtain these visualizations by concentrating the attention on the retinal field, endeavoring to form pictures out of what I see, and projecting them into a real scene. At first I see only the play of indefinite retinal light, which I weave into a picture with the help of imagination. Then all at once the picture becomes vividly real for an instant. I have never succeeded in prolonging these images. The effort to

observe them attentively always throws them back into their former state; and often the attempt to control them voluntarily has the same result.

The purely involuntary type of visualization, which is apparently the phenomenon observed in clairvoyance and crystal-gazing, occurs infrequently in my case; but I have occasionally had experiences of this sort in an unmistakable form. In a dark room with eyes closed a definite scene will appear before me in apparently as bright an illumination as daylight. I seem to be looking through my closed eyelids. The scene is apparently as real, as vivid, as detailed, as an actual landscape. The phenomenon lasts not more than a minute. I have never been able to hold it long enough to notice any change or movement. It is a scene—not a happening. The two most vivid cases occurred quite automatically, either as I was dozing off and for some reason came back to consciousness; or immediately on waking during the night. Once the scene was a tropical landscape, with palm-trees and a body of water. It was clear and detailed and appeared so real that I was surprised to find it unchanged by winking.

Relation to Earlier Work.—The types of phenomena reported above have been little investigated, though they have an important bearing on the mechanism of memory and on the relation of sensation to central imagery.

V. Urbantschitsch reported in 1903 [1] that in early life he was able voluntarily to call up color impressions with closed eyes. This power has diminished in later years; he can still bring up colored pictures but only with difficulty. This experience is apparently similar to my voluntary visualizations. In a later paper (1905) Urbantschitsch reports[2] that after an excursion in the country, on closing his eyes, he is often able to call up pictures of landscapes, with groups of trees and bushes. These visualizations may recur for several days after the original impression. He considers them memory-images rather than after-sensations. This expe-

[1] 'Ueber die Beeinflussung subjectiver Gesichtsempfindungen,' *Pflüger's Archiv*, 94, p. 423.

[2] 'Ueber Sinnesempfindungen und Gedächtnisbilder,' *Pflüger's Archiv*, 110, p. 479.

rience resembles the delayed after-sensations mentioned in the beginning of the present paper, except that the lapse of time is much greater—days instead of less than an hour. If the two phenomena are really due to the same neural processes, they bear on the relation between retinal and central processes.

G. J. Burch reported in the same year[1] an experience similar to my microscope effect. On his way to the laboratory he stopped several minutes to watch a pair of birds building a nest in the branches of a tree. On reaching his laboratory and turning out the gas in the dark-room, he obtained an after-sensation of the gas-flame for about ten minutes; then came a retinal fog, and afterwards there developed a picture of branches such as he had seen around the nest—a delayed after-sensation.

The first attempt at systematic investigation of these phenomena was made by V. Urbantschitsch.[2] Urbantschitsch distinguishes two classes of visual memory images (Gedächtnisbilder): (1) Simple representations (Vorstellungen, Bilder der Erinnerung), and (2) Visualizations (Anschauliche Gedächtnisbilder, Bilder der subjektiven Anschauung). "In the first case the object formerly seen is merely represented, in the second case it is subjectively seen again."[3] The latter phenomena were subjected to various experimental modifications by the author. It is not clear how he distinguishes them from after-sensations.

More recently these phenomena have been made the subject of a series of experimental studies by E. R. Jaensch and his pupils in the Marburg Psychological Laboratory. Two of these studies were published in 1920[4] and others are in progress.

[1] 'On Colour-Vision by Very Weak Sight,' *Proc. Roy. Soc.*, 1905, **76** B, pp. 211–2.

[2] 'Ueber subjektive optische Anschauungsbilder,' 1907.

[3] *Op. cit.*, p. 152, cf. p. 1.

[4] Paula Busse, 'Ueber die Gedächtnisstufen und ihre Beziehung zum Aufbau der Wahrnehmungswelt,' *Zsch. f. Psychol.*, **84**, 1–66. E. R. Jaensch, 'Zur Methodik experimenteller Untersuchungen an optischen Anschauungsbildern,' *Zsch. f. Psychol.*, **85**, 37–82. Cf. E. R. Jaensch, *Zsch. f. Psychol.*, Erzbd. 4, 1909, pp. 386–387. The present writer had not seen these studies when the first part of this paper was written. He is indebted to Professor E. B. Titchener for bringing the work to his attention.

Jaensch distinguishes three types of visual after-effect: (1) Nachbilder, (2) Anschauungsbilder, and (3) Vorstellungsbilder; which will be translated *After-sensations*, *Visualizations*, and *Memory Images*, respectively.[1] The Anschauungsbild or visualization is intermediate between the other two. Jaensch and Busse consider them as three grades of memory (Gedächtnisstufen).

The Marburg subjects were chosen with reference to their ability to obtain vivid visualization. It appears that some capacity for visualization is present in a large proportion of children; examinations conducted by the Marburg laboratory indicate that at least 37 per cent. of all children possess it in some degree. For the Marburg studies a number of young observers from 11 to 17 years of age were used, together with many older observers capable of visualizing.

After-sensations were obtained by the subjects after a 40-second exposure of the visual stimulus, visualizations after a 15 or 20-second exposure, and memory images after a 5-second exposure. The intensity of the visual stimulus is not stated, though this would seem to be an essential factor in repeating the experiments. After-effects of all three types were obtained *with open eyes*, and were usually projected onto a blank cardboard background. For the purposes of the experiments lines and other objective figures were placed on this same background. The subjects were able to hold the after-effects and compare them with the objective figures.

The experiments aimed to discover definite laws governing visual after-effects, comparable with the laws of visual perception. Busse found that if the head be turned about the sagittal axis after the phenomena has been obtained, the memory image deviates from its original projective position less than the after-sensation; *i.e.*, there is more change with reference to the shifting optical axes in the memory image than in the after-sensation. The change in the visualization picture is intermediate between the memory image and after-sensation. The area of the field of vision was found to be

[1] The first and third of the English terms may be objected to as involving a theory of origin; but the second is freer from theoretical implications than the corresponding German term.

generally greater in the memory image. In general, memory images were flat, visualizations stood out in relief, and after-sensations appeared solid. Visualizations were compared with visual perceptions by means of a pair of (objective) threads and the after-effect of another pair of threads; it was found that the mutual influence of perception and visualization diminishes as the difference between the distances measured by the two pairs increases. After-effects are progressively less clear in detail as we pass from after-sensations through visualizations to memory images.

Jaensch, experimenting with visualizations, finds that both the law of identity of the binocular line of vision and the law of incongruence of the two retinal fields hold for visualizations, the same as for visual perceptions. Visualizations withstand voluntary control more than memory images; in other words, memory images are more plastic than visualizations.

The Marburg experiments had especially in view to demonstrate that visualizations are not produced and altered by suggestion, but are orderly (psychonomic) mental phenomena;—that they are as capable of definite experimental investigation as perceptions. The results reported, and the general agreement among the 100 observers after due allowance for differences in mental types, appear to substantiate this conclusion.

Physiological Basis of Visual After-effects.—The most important problem in connection with visual after-effects, in the opinion of the present writer, is their point of origin: Are they generated peripherally or centrally?

(*a*) In the case of *visual after-sensations* there seems no reason to doubt that they originate peripherally—that they are due to physiological processes in the retina itself.

(*b*) As regards *visual memories*, the accepted opinion among psychologists is that they depend upon cerebral retention: (1) It is difficult to see how such a vast number of visual impressions could be retained in the retinal substance for an entire life-time. (2) There is no known motor mechanism for the voluntary revival of such traces in the retina, even supposing them to have been retained.

The delayed after-sensations of Burch and the present writer weaken the first argument somewhat. It is evident that after-effects may persist in the retina despite subsequent, rather intense stimulation of the same retinal regions; that after a latent period of thirty minutes or longer they may give rise to renewed sensations. The question then arises how long this retinal retention can last. Are the after-effects reported by Urbantschitsch as occurring several days after his trip to the country phenomena of central origin, as he believes, or are they delayed after-sensations?

The second argument still holds. The absence of motor nerves in the retina supports the view that retinal retention is only a secondary aid to memory—that the stream of visual memories is controlled centrally and not through a retinal mechanism.

(*c*) Turning now to *visualizations*, the question of their source is somewhat perplexing. The writer's involuntary visualizations of childhood (*e.g.*, the changing color patterns) seem to be retinal; if not real after-sensations, they are apparently due to physiological processes in the retina. On the other hand, the visualization of the tropical scene was too definitely pictorial to have been caused by casual retinal stimulation; nor was it a delayed after-sensation, unless an effect of many years' standing or the amplified retention of some photograph or picture. Its definiteness of outline and content mark it as peripheral; the other evidence is entirely in favor of its central origin. Dream visualization and crystal gazing seem to belong in this category.

My voluntary visualizations in mature life appear to be based on casual retinal processes, which are amplified into meaningful scenes by the addition of central elements. Retinal stimuli are apparently essential to my present visualizations; in childhood they apparently played an unimportant rôle. Neither in childhood nor today have I succeeded in getting pure visualizations with open eyes, like Jaensch's subjects.[1] Were the Marburg experiments per-

[1] I can weave the indefinite markings of colored marble into scenes, see pictures in smudges, etc. My ability to recultivate visualization in later life may be due to

formed less rigidly, I should consider the 'Anschauungsbilder' to be a kind of prolonged after-sensation. As it is, they seem undoubtedly to correspond to my visualizations; but they are far more vivid, as shown by the fact that they persist in all their definiteness with open eyes.

While my own experiences may be brought fairly well into line with Jaensch's, my classification would be slightly different. At one extreme is the visual *sensation*, due to objective stimulation; at the other the *memory image*, which in my case is a thought, rather than a visual picture. Between these extremes I distinguish three classes of visual after-effects which occur with closed eyes.

1. *Pure After-sensations.*—These are clear-cut and vivid. They are easily recognized as real; that is, there is no question of mistaking them for figments of the imagination. They bear all the marks of being aroused by retinal stimuli.

2. *Mixed After-effects.*—Here the after-sensations are not themselves definite, but they seem to be woven into definite figures and scenes by the addition of central imagery. If the image element predominates, the scene can be voluntarily controlled; if not, it is refractory. This type is recognizably different from the first; the pictures are not projected out, and there is no filling in of details. It is a partial visualization, but is largely dependent on retinal factors.

3. *Pure Visualization.*—The 'tropical scene' experience is the best example of this type. The visualized picture is even more vivid than an after-sensation. The details are lifelike, but in my case do not admit of careful examination; I should say that the outlines and content are not so sharp and clear as in pure after-sensations. The experience seems 'real,' though obviously it is not external. Dreams, hallucinations, and the phenomena of clairvoyance apparently belong to this type.

Visualization offers a promising field for research. The writer believes the visualization experience to be a combina-

monocular limitations. My left retina is normal but the left cornea is defective; so that distinct impressions are obtained only with the right eye. Possibly my after-sensations are more definite and persistent on this account.

tion of peripheral and central elements. The correctness of this explanation and the extent of the contributions from each source, would seem to admit of experimental determination. A retinal after-effect is affected very definitely by any new stimulus; while central after-effects presumably are little altered by external stimulation. Changes of general illumination, winking, eye-movements, attempts at voluntary control—one or more of these factors might prove a satisfactory criterion to distinguish the central from the peripheral elements in a visualization.

The radical behaviorist has a further task. If the phenomena which we call memory and imagery are determined in every case by motor factors, as the behaviorist asserts, he must discover the motor path leading to the retina which arouses visual memory images—for according to behaviorism the memory image is a motor-sensory affair.

Summary.—Several cases of long delayed after-sensations were described; also an unusually prolonged after-sensation of glare. Observations were reported of vivid visualization (both voluntary and involuntary) in childhood and in later life.

These personal experiences were compared with earlier observations and experiences. The first systematic treatment of the phenomena was by Urbantschitsch. Jaensch's recent work is an attempt to investigate them by laboratory methods. He finds that visualization pictures (Anschauungsbilder) can be obtained with open eyes; that they can be compared with objective perception-pictures, and that they can be subjected to rigid experimental tests. Jaensch divides visual after-effects into three grades: after-sensations (Nachbilder), visualizations (Anschauungsbilder), and memory-images (Vorstellungsbilder).

An important problem for future investigation is the source of these various phenomena,—how far they are due to peripheral and how far to central processes.